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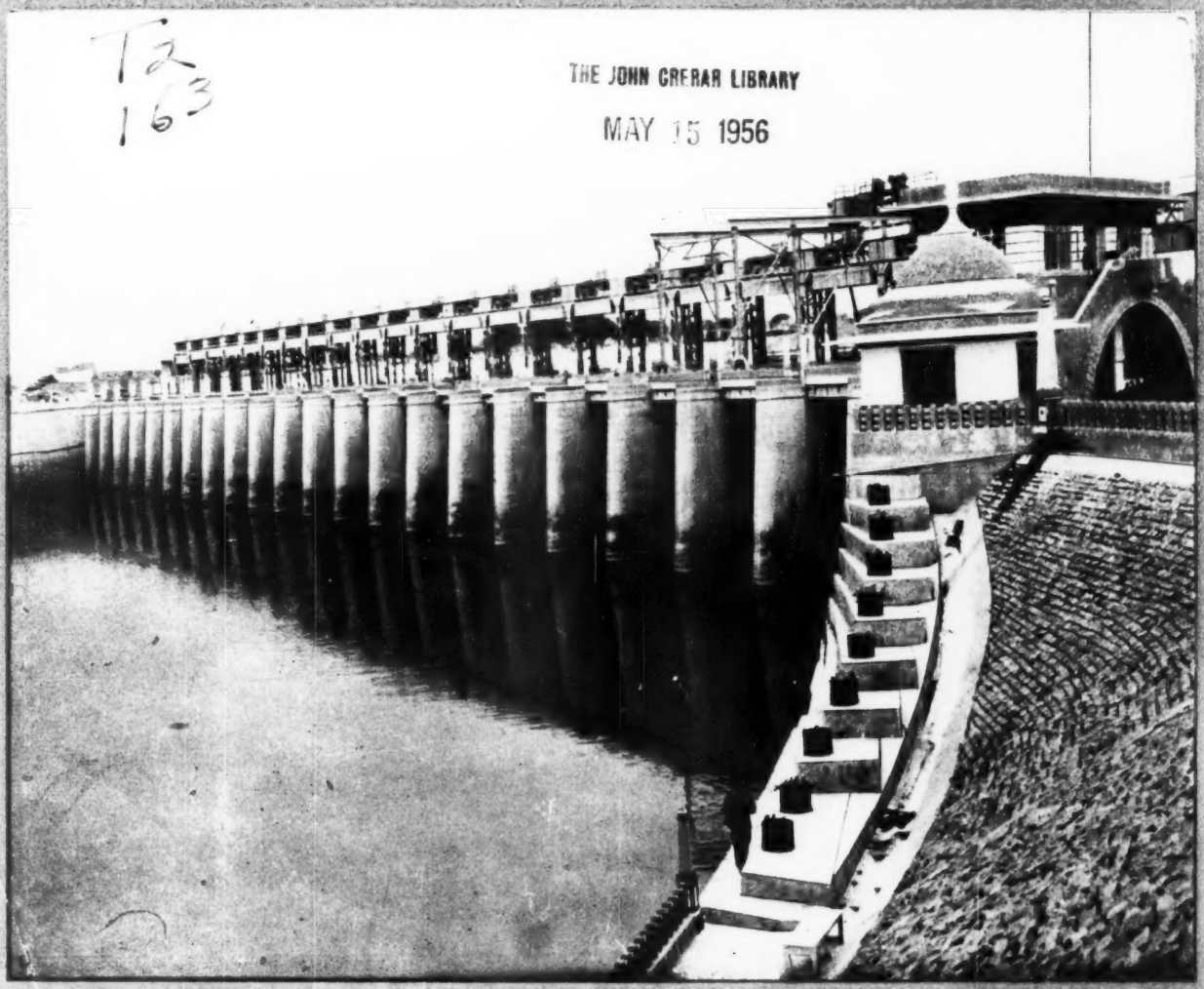

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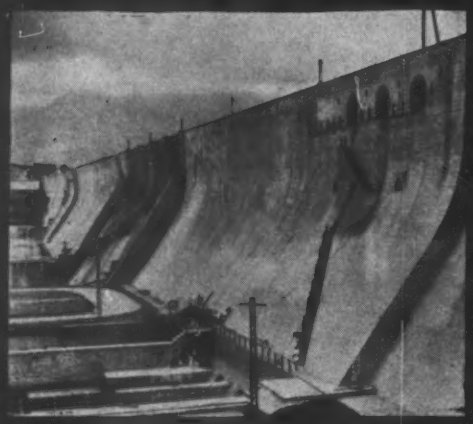

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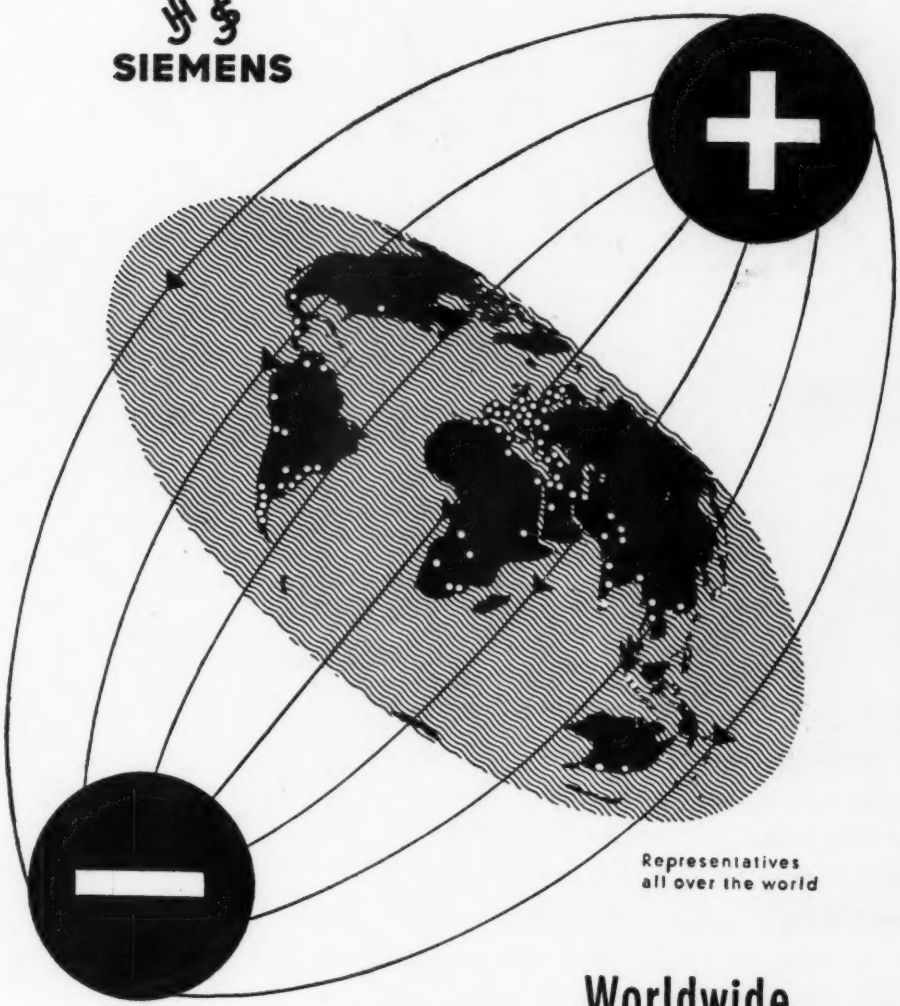

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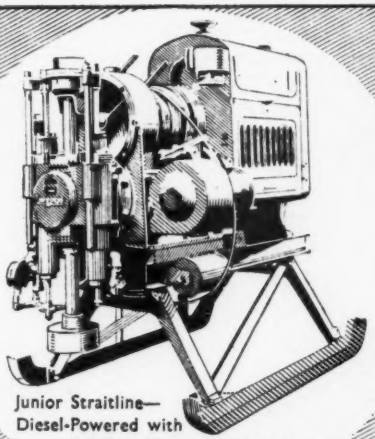

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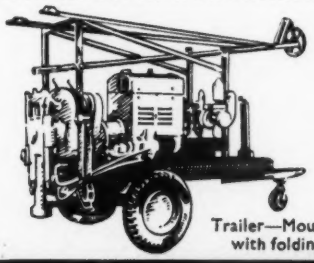

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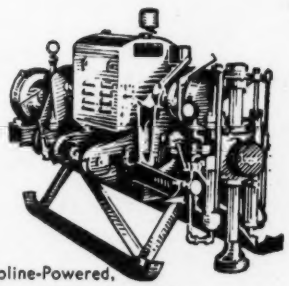

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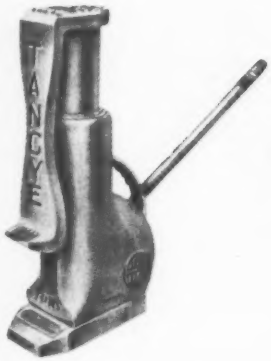

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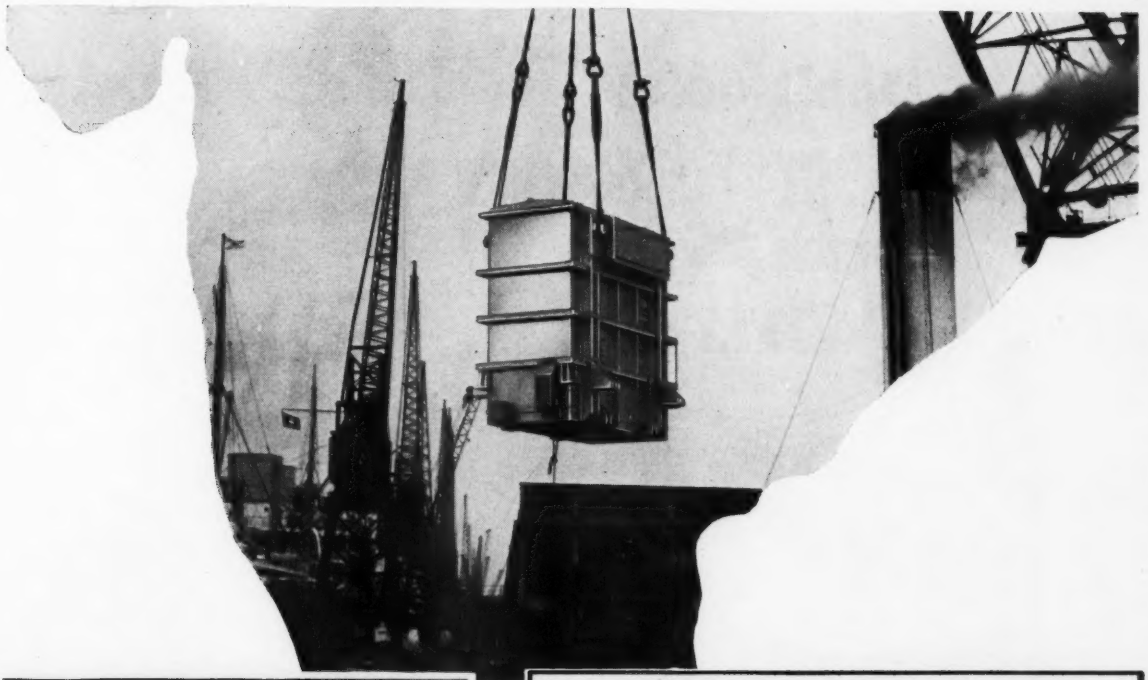

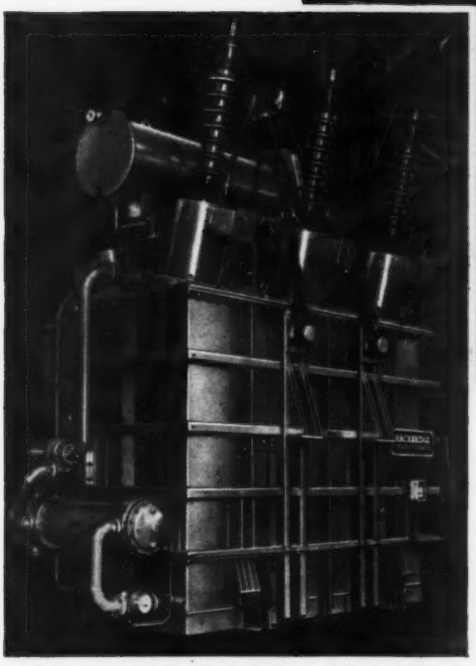

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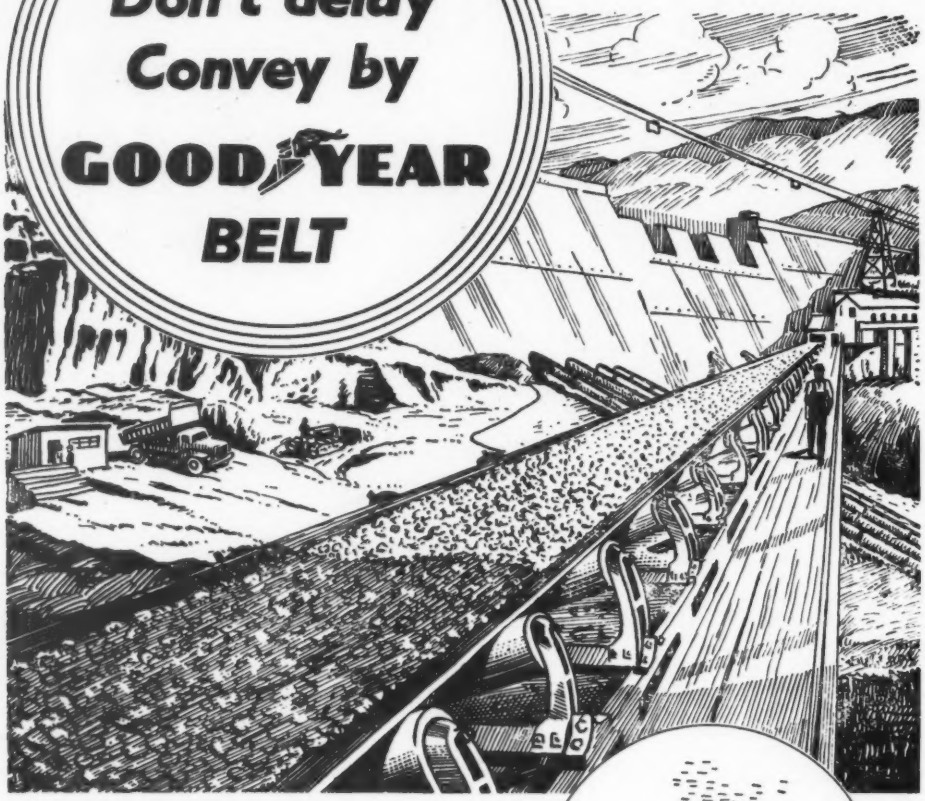

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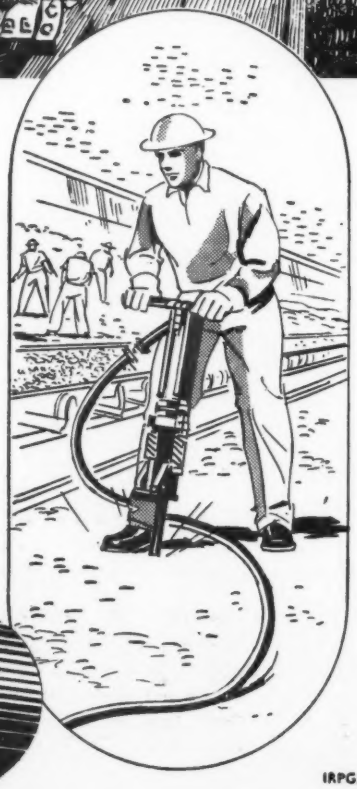

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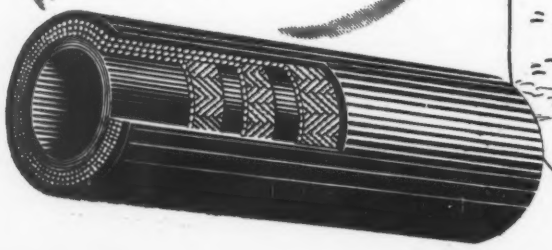

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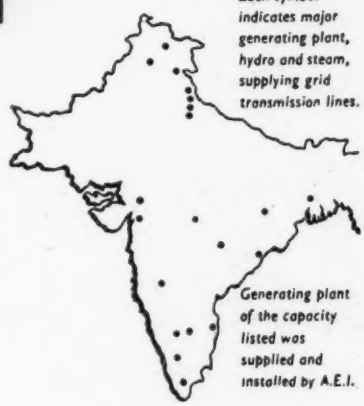

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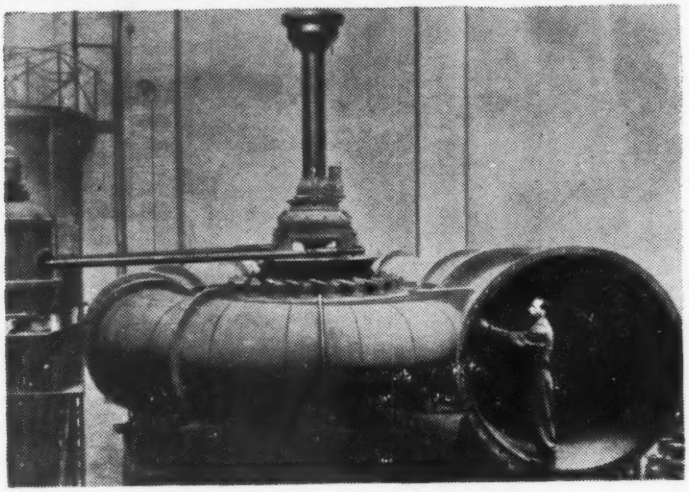

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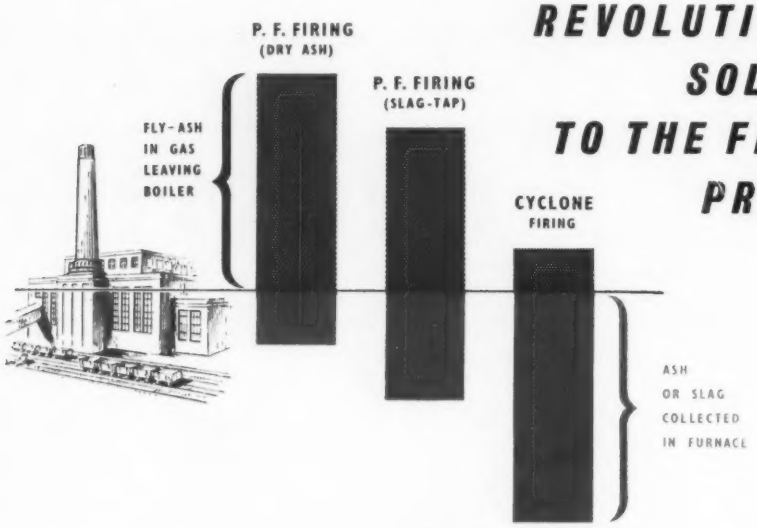

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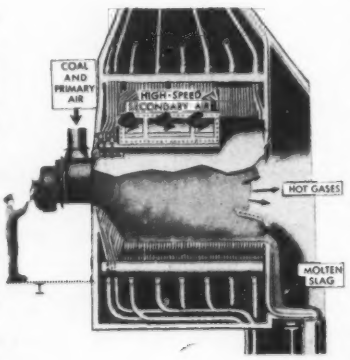

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A MONTHLY DEVOTED TO DEVELOPMENT OF POWER & WATER RESOURCES IN ASIA

Editor : K. K. Sinha

P. K. Menon : Mg. Editor

Vol. VI | January, 1956 | No. 1

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Delhi Office
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Cornwallis Road
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Editorial and Managerial Offices
6/2, Madan Street, Calcutta-13
Phone: 23-1765 ; Gram: Tekjourn
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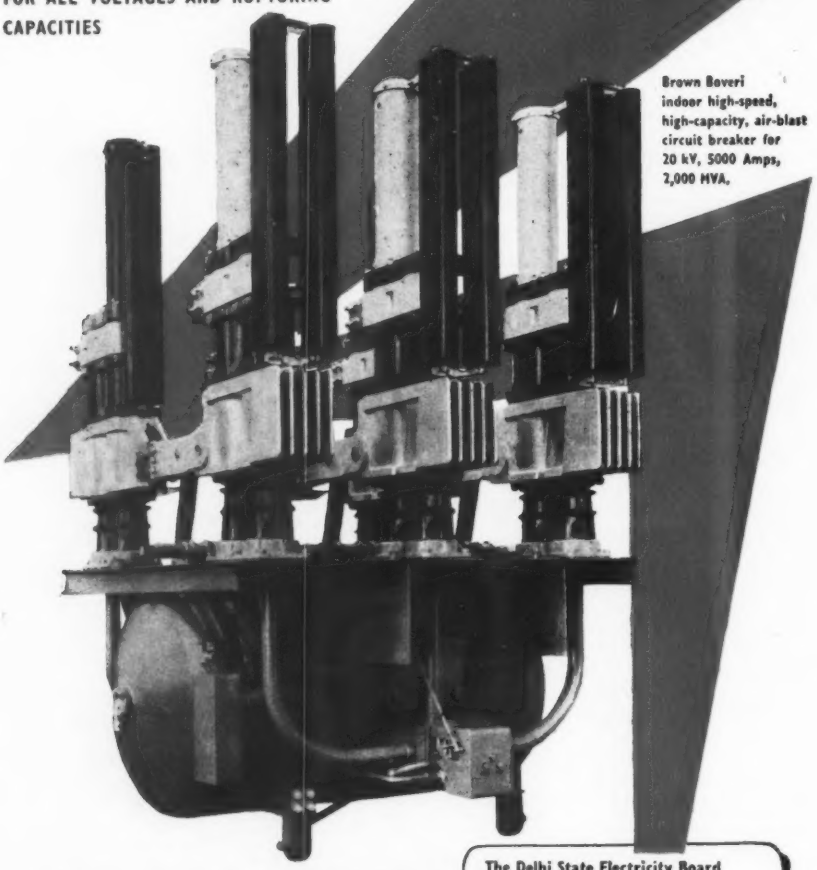

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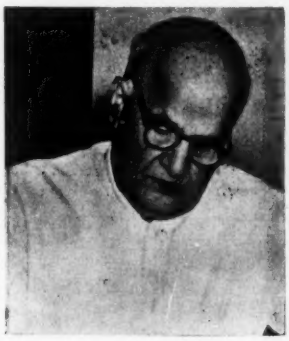
Some Problems of Irrigation Development

V. T. KRISHNAMACHARI



AUTHOR

Being his Inaugural Speech at the Twentysixth Annual Meeting of the Central Board of Irrigation and Power held at New Delhi on November 8, 1955. He provides here the broad perspective of Irrigation development in India and formulates the problems of financing these huge plans in the context of an under-developed economy like that of ours. He also raises the problems of coordination of the various aspects of execution of the projects so that maximum value of the expenditure incurred is secured without delay.

The irrigation plan for the first five-year period was an ambitious one though in relation to our needs it was modest. The area under irrigation when the Plan began can be classified as follows :—

(*i*) the area which had secure, perennial irrigation under Government canals and big government tanks ; (ii) areas under minor irrigation, private canals wells etc., under which irrigation cannot be as secure as under the first class works. The first group, that is, the area under large irrigation works was about 26½ million acres, about 18 million acres under government canals and the rest under government tanks. The remaining area—about 22 million acres—was under private canals, wells and other sources. The book value of the works that came to India's share at the time of partition was about Rs. 110 crores. This represents largely the book value or irrigation under government canals and a portion of the irrigation under other government tanks. We may say roughly that this amount represents the book value for irrigating about 20 million acres. On an average this works out to about Rs. 55 an acre and in terms of current prices, it will be above five times that amount. That is, Rs. 110 crores of those days might mean about Rs. 550 crores in modern prices. The earlier irrigation works were not so expensive as the present ones. There was then no need for expensive dams and reservoirs which have now become necessary for utilising supplies available in our rivers.

In the First Five-Year Plan we included irrigation works the total estimated cost of which was Rs. 708 crores. These are for works which come under the category of multi-purpose and large and medium projects. It is estimated that as a result of this expenditure, 23½ million acres will be added to the irrigated area. These 23½ million acres will have irrigation like the irrigation of about 20 million acres under government canals—the first class permanent irrigation. In the Second Five-Year Plan we have provided new projects costing Rs. 363 crores which will irrigate an additional area of 13.8 million acres. In this category thus, in the First and Second Five-Year Plan, the total cost of irrigation works i.e. multipurpose and large and medium works would be Rs. 1071 crores and the additional irrigated area—I am talking about the area which will get permanent irrigation—would be 37.2 million acres. All this irrigation will not be actually obtained in the first two Plan periods : some of this will be achieved only in the third Plan. Of these 37.2 million acres, we have already got an additional irrigated area in the First Plan of about 7 million acres. We expect to have about 15 million acres in the Second Five-Year Plan and the rest of the 15 million acres will be actually irrigated in the third Plan. Of course, in the third Plan we shall have more works added. But what I have said will give you an idea of the progress that we are aiming at in irrigation. To sum up, we may say that to the 20 million acres of permanent, secure irrigation that we had at the beginning of the Plan we are seeking to add 37 million acres involving an expenditure of Rs. 1071 crores. In other works, we practically treble the area we had under permanent irrigation at the beginning of the First Five-Year Plan. Coming now to the second category of irrigation, in the First Five-Year Plan, we have added about 9 million acres under minor irrigation, wells and so on. We expect to add 9 or 10 million acres to minor irrigation in the Second Five-Year Plan. Thus, 18 or 19 million acres will be added to minor irrigation in the First and the Second Five-Year Plans.

We find that the cost of irrigation—of providing permanent irrigation—varies from region to region. In the north, it works up to about Rs. 250 to Rs. 300 per acre ; in the central region to Rs. 350 to Rs. 450 per acre ; down south, where irrigation schemes provide for rice cultivation, the average works out to about Rs. 600 to Rs. 650 an acre. These figures will give you an approximate idea of the magnitude of the financial costs that have to be incurred for irrigation by Government canal systems.

Scope for further Expansion

It may be asked—what is the scope of further expansion ? What is the target of additional irrigation ? What are the possibilities of irrigation development under different kinds of sources in this country ? I

V. T. Krishnamachari *is Dy. Chairman, Planning Commission, Government of India*

have worked this out roughly. We have not got adequate data for a correct assessment. I think, however, that there is no reason why under governmental canal systems, i.e. multi-purpose and large and medium irrigation systems, we should not eventually have about 75 to 80 million acres under irrigation. I also estimate that we can have an equal area under other categories of irrigation sources. Thus about 150 to 160 million acres, in the aggregate, can be brought under irrigation—half of this area under large and medium projects with canal systems which afford much greater security for crops than the other category of irrigation. But I must repeat that we have not got adequate data for a correct assessment of the possibilities. Nearly 50 years ago, an all-India survey was made of irrigation possibilities by a Royal Commission. There has been a great change in conditions since then. Firstly there have been improvements in techniques of dam construction and in irrigation engineering generally. Schemes which were considered impossible in those days have now become practical propositions. In another field also there has been a large increase in experience, i.e. in techniques of dry-farming. Some time ago, it was thought that irrigation afforded the only means of increasing production in agriculture. In recent years, there has been a great advance in our knowledge of techniques of dry-farming—contour bunding, soil conservation and so on. Our estimates of possibilities of irrigation in this country have to be revised from both these angles and I suggest that in the early years of the second five-year plan a careful survey should be made by Chief Engineers in every State of the future possibilities for large and medium irrigation projects and for minor irrigation schemes like tanks, wells and also the point at which irrigation ceases to be useful and we should advocate the wide adoption of dry-farming methods. In the second five-year plan, we have provided a sum of Rs. 5½ crores in the plans of the States for further investigations. I suggest that your Board might consider how the investigations in all States might be co-ordinated so as to proceed on a uniform pattern covering the points I have mentioned. It is only on the results of these investigations that we can form a correct idea of the possibilities of development in three directions which I have indicated—viz. how much irrigation can be developed under government reservoirs and canals, i.e., large and medium irrigation wells; what are the possibilities of developing irrigation under minor irrigation works, wells ; etc : and thirdly, the possibilities of the adoption of dry-farming techniques —contour-bunding, arrangements for the preservation of soil moisture etc. Such investigations will give us material for the formulation of our third and and further plans. Assuming that the forecast I make is roughly correct,—viz. that there is scope for 75 to 80 million acres of irrigation under large and medium irrigation projects and for an equal area under minor irrigation works, you can work out the sort of financial outlays that will be needed in the coming plans.

At this stage, I should like to mention that it is not the intention, by incurring all this expenditure on irrigation, to increase cereal production. What we aim at is the diversification of the agricultural economy. We have all the cereal production that we need. We develop horticulture, protective foods, animal husbandry, poultry farming, fisheries etc. The Planning Commission has placed before the country the ideal of doubling rural incomes within ten years. If agricultural techniques are improved and irrigation facilities are provided on the scale we have in mind, this target can be achieved.

Principles of Financing

What I have said so far brings me to the question of financing of projects to which reference has been made in the President's speech. He has made the point that as irrigation projects produce indirect benefits they should not be regarded as "commercial propositions" and that the financial test now applied, viz—that of recovery of capital cost and interest over a long-term of years,—should be relaxed. He has mentioned the example of Australia where, in calculating financial returns, that cost of dams is excluded. Now, there is no doubt that these large and medium irrigation schemes produce indirect benefits. Nobody can deny that. Whether these indirect benefits can be assessed in concrete terms is a different matter but this point is not important. We have in the world two kinds of economies. There are the developed countries in which agriculture as an occupation is practised by about 20 per cent of the population and in which 80 per cent of the population are engaged in industries from which high levels of *per capita* income are secured. Such countries are U.S.A., Canada, Australia, etc. Then there are the under-developed countries like India and China where agriculture is practised by 70 to 80 per cent of the population who produce about 50 per cent of the national income. The rest of the people (20 to 30 per cent) are in non-agricultural occupations and their *per capita* income is at a low level of economic efficiency. The problem of financing development must differ in these two economies. In the U.S.A. where the national income is very high, there are enough resources for subsidizing irrigation projects and price support policies for agriculture. As the result of this latter policy, there were surplus stocks with government of the value of which some time ago in terms of our money was over Rs. 3000 crores—nearly, the total size of our first five-year plan in the public and the private sectors. It is easy to understand why in India we cannot afford to subsidize irrigation projects as these countries do. Assuming that half the cultivated area can have irrigation in our country and that projects for this area have to be subsidized, from whom will the subsidy come ? The other half of the cultivated area which cannot obtain irrigation facilities cannot obviously bear the burden. Nor can the 20 to 30 per cent who draw small *per capita* income from non-agricultural occupations. And irrigation is only one part of national development. The problem of resources for development is the most difficult we have to face. The Planning Commission gives earnest consideration to it in all its respects : and we are convinced that irrigation works on the scale that we need can be undertaken only if two principles are accepted for financing them. The first is that areas which are advantageously placed and have facilities for irrigation, especially canal irrigation, must pay betterment contribution. Secondly, irrigation must be recognised as a commercial service which should pay for itself. Unless these two propositions are recognised and acted upon, we cannot finance irrigation development on the scale which we contemplate. I do not see anything repugnant to public policy or social justice in laying down that lands which are advantageously situated

for irrigation should bear these charges. After all, there is the additional value imparted to land by irrigation, especially irrigation that i secure and perennial. Why should not a portion of it come back to the community for financing future developments ? Then, as the result of irrigation, production increases considerably. Why should not a portion of the increased produce be paid for meeting the cost of maintaining the works and repaying the loans raised for construction ? There are, of course, special cases in which this rule should be relaxed—for example, projects in chronic scarcity areas. But the general principle should be observed if we are to be able to undertake programmes of irrigation which the courty needs.

Obtaining the Maximum Value

I now pass to a most important question we should ask ourselves. It is this : Do we obtain the maximum value in every way for the expenditure that we incur on these large projects ? That is a question which I would invite you to consider very carefully in your deliberations. Do we, under the present arrangements for the execution of these projects obtain the maximum benefits that are obtainable from the expenditure that we incur on them ? My own conviction is that it is possible by better organisation and planning to obtain larger benefits from the present expenditure than we are doing now. There are, speaking generally, three groups of activities which have to be co-ordinated and closely inter-related, in the planning and implementation of these projects. First of all, there is a technical agency, i.e. Chief Engineers and others who are working under them. They make preliminary surveys of a project in consultation with revenue and other officers and after the project has received preliminary approval, prepare final plans and estimates. At these stages, the questions engineer should ask themselves are these : Firstly, is our plan sufficiently detailed ? Does it cover everything right down to field irrigation ? Secondly, are financial estimates reasonably accurate and do they make provision for all items that can be anticipated ? Thirdly, there is the phasing of the works programme. It should be phased in such a way that there is the maximum return on expenditure at every stage of the project. At no stage should capital be locked up without return. To give an example, the reservoir is completed and the canal system takes years after that. This leads to waste. There should be no time-lag between availability of the water and its full use for irrigation. I have seen projects in which the use of the water takes years after the completion of the reservoir. This as I have said is a national waste. Secondly, there are adminitrative and financial agencies. There are delays in land acquisition and delays again in complying with financial rules which are avoidable—delays in checking works, making payments, audits etc. Thirdly, I come to something much more important—what I call popular cooperation. We cannot obtain the maxiuum benefits of a project unless, from the commencement, the people have been prepared for making the best use of irrigation facilities as soon as they become available. All the three processes to which I have referred should be synchronized. When engineers begin to plan, revenue and agricultural officers should also begin their plan. They should prepare the people for the irrigation and see that they are taught the scientific use of water and the maximization of production. As you know, in the Planning Commission, we attach importance to the National Extension movement as the agency for rural development and social change. We have suggested that when a project is taken up and it is known that area will be under irrigation, the State Government should establish National Extension blocks in the commanded areas for seeing that the people are trained in their responsibilities. The National Extension agency unde the district officers will explain to the people why they are called upon to pay betterment contribution and water rates ; will see that demonstration farms are established to accustom people to the use of irrigation ; will take steps to ensure that lands are prepared for receiving irrigation when water becomes available : that the canal system for each village is constructed by village cooperatives in time : and will ensure in all ways that the best benefits are obtained from the projects. I would suggest that a group among you should study how the organisations concerned should work together and make proposals to your governments. I repeat that the time-lag in the utilisation of water is a national waste. Under every irrigation project again there is room for economy of water and increase of production per acre. Here again, the National Extension Service agency has a useful role. What is needed is co-ordinated action which will see that delays in all such stages are completely eliminated.

I now come to flood protection schemes to which the President has referred. The Prime Minister placed this whole subject in its proper perspective in his speech in Orissa last September. Two points should be stressed. Firstly, we must define rigidly the scope of these protective measures. Every reservoir gives a certain measure of flood protection and the precise scope of the flood protection programmes which have been recently inaugurated should be defined. Secondly, there is no doubt that a great deal of research and investigation are needed before the efficacy of different measures of flood protection can be definitely assessed. I again ask that the entire question should be viewed in the light of what the Prime Minister has said in his Orissa speech.

In his closing remakrs the President has talked about an All-India Service of Engineers and of the need for raising the position of irrigation engineers. I myself believe that the irrigation engineers in this country have played, and are playing, a great part in the country's development and have no doubt whatever that the Central and State Governments will do all they can to see that their legitimate position is maintained and their rights are safeguarded. The need for efficient irrigation services in the country is also admitted. The States' service should be linked up together. They should not be isolated but should learn from one another and pool their knowledge and experience. I believe discussions are going on with States in regard to an All-India Srevice. There is no doubt that the country needs large programmes of irrigation development and that backward regions should receive special attention. For all this, we need an efficient, well-organised Service of Engineers and I am certain that States will co-operate with the Central Government in measures for bringing such an organisation into existence.

Opening of the Afro-Asian Water Reso

JAWAHARLAL NEHRU

The much-needed International Centre for Training in Water Resources Developmen
Conference. It may be interesting to nate that in recent years river valley projects have been
Africa. These plans for an integrated development of a regoin require technical personal of a
to others in river valley projects has undertaken to establish the Centre at Roorkee which is the oldest
Jawahar Lal Nehru and the speech of Sri. A. N

Summary of the speech of the Prime Minister delivered at the Inauguration of the Asian Training Centre on 25.11.1955 at the University of Roorkee, Roorkee.

I am happy to be here for a variety of reasons. First of all I am not only interested in but I am convinced that the growth and development of India, the building up of New India, depends upon the growth of engineering talent in this country. Engineering and engineers are, and are going to be basic element in this building up of new India. Indeed we see them even now incharge of great schemes, great schemes in every state, great schemes which have a national importance all over the country and some which are known even outside the country. So that one reason is this that I am glad to be here. The second reason is that when I came here five years or six years ago, I have forgotten, say six years ago, I saw this ancient building a hundred years old and now when I came here I wanted to see the changes made, the progress that has taken place during this period. The third reason and the most important reason is that in a way the opening of this International Training Centre for Water Resources Development is connected with a promise given at the Bandung Conference at the beginning of this year. The general promise was to promote cooperation between countries of Asia and Africa and to offer opportunities of training as well as our help that is within our capacity to our sister nations of Africa and Asia. This particular matter was also mentioned then at Bandung and so I am happy that in inaugurating this ceremony today we are fulfilling a promise made earlier this year at Bandung and thereby taking another step forward towards the cooperation of the countries of Asia and Africa and ourselves.

In all these countries wherever they are, there are teething troubles more or less similar to ours. Of course problems differ but broadly speaking all these countries are under-developed in an economic or industrial sense. Therefore we all have to face the problems of under-developed countries. Compared to many of them India is much more developed. It is our good fortune to be so and we have made good progress even in the last five years or more and now I believe that we stand on the threshold of much more rapid progress in the state of development of the country, industrialization and the like. Indeed I believe that the changes that have taken place or are going to take place in the next five years are in the nature of revolutionary changes in our economic, industrial and social set-up because these revolutionary changes that are taking place go rather quietly, rather peacefully without much shouting. People do not quite realize how they are changing the fate of the country. Not only big schemes but our community development schemes which are really changing India from the grass roots upwards or from the village upwards. It is the village that counts ultimately. Change in India can be measured by the change in the Indian villages. It does not matter how many factories you put up, how many new buildings you put up. They are good. Put them up by all means but if you want to measure the change in India you have to measure the change in the village for the simple reason that 75 to 80% of the people live in the villages. There is no special virtue in the village but the virtue lies in the persons living in the villages. Let every engineer remember that if our big schemes are important, it is because they are going to affect the village.

Summary of Sri A. N. Khosla's Speech

This great Institution was founded in October 1847. Throughout its existence of over a century, it has maintained its tradition of high performance, sense of the first rate, discipline, hard work and character building. Since its conversion into a University six years ago, the scope of its activities has been steadily widening to cover post-graduate studies, research and specialised training.

Two post-graduate courses were started for the first time in the academic year 1953-54. Two additional post-graduate courses were introduced in 1954-55 and two more during the current session.

Hydraulic research was pioneered at this Institution as far back as the early nineties of the last century. For various reasons, however, this classic work was not pursued. During the last 50 years or so little has been done at this Institution in the way of research. Research activity is now being revived and, for the first time, 18 research problems, sponsored by the Council of Scientific and Industrial Research, are being taken up. It is my earnest hope that more and more problems will be taken up during the years to come and that basic research will soon get firmly established at this University and will progressively

Resources Development Training Centre

velopment has at last been opened at Roorkee University. The matter was raised at the Bandung ave been in the forefront of national economic development plans of many countries in Asia and onal of a high calibre in large numbers. It is gratifying to note that India which has given a bold lead the oldest engineering institution of the country. The following gives the Inauguration Speech of Pt. ri. A. N. Khosla, Vice-Chancellor of the University.

A. N. KHOSLA

be extended into the applied field in collaboration with Governments and industry. With this end in view the University laboratories are being reorganised and modernised. Equipment of the latest type is being procured. The Electrical Engineering Laboratory Block has just been completed. Construction of two Civil Engineering Laboratory blocks is being shortly taken up.

Specialised training for serving engineers has been introduced through short term lectures. Refresher courses for the purpose were inaugurated by Shri V. T. Krishnamachari, Deputy Chairman, Planning Commission, on the first of this month. The introduction of Refresher Courses has been a major step forward and an important landmark in the University's plan of development. These Courses will help the serving engineers to brush up their knowledge and bring to them the latest advances in engineering techniques and practice, thus bringing about a happy blend of academic training and laboratory research with the application of that training and research to field operations and industry. The need for Refresher Courses has been there for many years but has become pressing and assumed special importance after independence, because of the extensive and varied programme of development since taken up which has thrown up new problems, the like of which had never been encountered before.

The University has embarked during the year on a new experiment in *Shramdan* which inculcates in the student body a sense of civic responsibility and and dignity of labour and at the same time provides practical training in the engineering field. The students have constructed with their own hands, under guidance of the teachers, a substantial addition to the engineering students club building, the roof of which is expected to be completed by end of December. A more notable and spectacular achievement of the student body is the construction of the Swimming Pool and the Open Air Theatre which you have been gracious enough to open just now. This has been constructed mainly with students and staff labour and stands as a monument to the spirit of service and industry of the student community. They have done earth-work, carriage of materials, foundation concrete and masonry of walls, have cast heavy reinforced girders and hoisted them in position on the roofs and have laid reinforced concrete roof over nearly 3000 sq. ft. of area. It was heartening to see these young students at work with soldierly discipline and missionary zeal It has been a wonderful demonstration of what determined effort can achieve. The student community, through working with their own hands, have learnt the gospel of dirty hands and gained first hand experience of constructing eingineering works which will stand them in good stead when, later in service, they will be called upon to organise, supervise and execute major works. The University is indebted to Col. Y. R. Puri the Commandant and other officers and ranks of the Bengal Engineering Centre who have co-operated in this venture by imparting valuable training in the use of hoisting, concreting and earth moving machinery.

It is proposed, in the near future, to extend *Shramdan* to other fields of engineering activity such as water supply, sanitary facilities, house wiring, winding of motors, repairs and overhaul of machinery and other engineering jobs.

The Second Five Year Plan of the University provides for a progressive increase in the number of special subjects to be taught at the undergraduate and post-graduate level and a corresponding increase in the number of students. It also provides for expansion of basic and applied research. Because of the limited funds allotted to the University for the Second Five Year Plan, the expansion will be necessarily slow. These limitations notwithstanding, we have steadfastly to keep our eyes on the goal of making this University, the most modern University, embracing in its scope all branches of engineering and specialised subjects and becoming a great centre of post-graduate and specialised training and research, and open to nationals from all countries.

The establishment of the Water Resources Development Training Centre at the University marks a historic phase in the development of this University and projects its activities in the international field. This Centre is being established by the University of Roorkee, with the help of the Government of India, in pursuance of the announcements made in March this year at the ECAFE Conference at Tokyo and in April at the Asian-African Conference at Bandung. The object of this Training Centre is to provide serving engineers from all over Asia and Africa the oppor-

tunity of studying the latest developments in engineering techniques, including social and economic aspects, in the development of water-resources. The courses to be organized at the University will cover all aspects of water resources development, including basic principles and important details of planning, investigation, design, construction, maintenance and operation of multi-purpose river basin development projects and their technical, financial and human aspects. Each course will be of 12 months duration and will be divided in terms, set apart for lectures, field work, inspection trips and the preparation of a project. The facilities at the University will be supplemented by those available at the Central Building Research Institute, the U.P. Irrigation Research Institute and the U.P. Government Workshops at Roorkee and the Survey of India and Forest Research Institute at Dehra Doon. For field training and visit to works, the trainees will be sent to multipurpose projects like the Bhakra-Nangal, the D.V.C., the Hirakud, Chambal, Koyna and other projects. The vast net work of existing canals, tube-wells, power houses and research stations in various parts of India will provide field training in maintenance and operation and an insight into water and power research problems.

The Government of India has sanctioned a recurring expenditure upto Rs. 2,56,000 per annum to meet the cost of running this Center. In addition they have sanctioned loans to the value of Rs. 9,46,000 for the the construction of a hostel for trainees and residences for specialist staff. These buildings are under construction. Certain essential equipment is being procured under the T.C.M. programme. In addition the T.C.M. is providing three specialists and the U.N. Technical Assistance Board, two specialists. A number of short term lecturers will be provided by the ECAFE., U.N. T.A.A. and T.C.M. Eight specialists are being recruited in India, including understudies for those being provided by the T.C.M. and T.A.A. Also a considerable number of short term lecturers will be drawn from India.

The U.N.T.A.A. has offered five fellowships to be awarded to candidates selected by the University for admission from the ECAFE region.

Because of the financial implications and the need for obtaining necessary clearances, it was not possible to address various governments earlier than the middle of October. Despite the short notice, requests from these governments for admission of their nationals to the Centre are gradually coming in.

The proposal for establishing a Training Center for Water Resources Development orginated with ECAFE about 3 years back but could not be implemented for want of funds. This proposal was revived in October 1954, when Mr. R. C. Price, Member, Flood Control Bureau, ECAFE came at the instance of Mr. C. H. Willson, Director, Technical Co-operation Mission, to Roorkee to discuss the possibility of establishment of this Centre at Roorkee. Discussions have continued since, culminating in the establishment today of the Water Resources Development Training Centre at Roorkee. Shri C. L. Handa, Director Bhakra Designs and Mr. Clarence Rawhauser of T.C.M. rendered most valuable assistance during these deliberations and the University is greatly indebted to these two officers. Appreciation and thanks of the University are due to Dr. P. S. Lokanathan, Executive Secretary, ECAFE, Dr. Shen-yi, Chairman, and Mr. R. C. Price, Member, Flood Contrl Bureau and, in particular, to Mr. C. H. Willson and his officers for their all out co-operation and most valuable advice in the setting up of this Centre. The University is most grateful to Shri G. K. Chandiramani Educational Adviser (Teohnical) and Professor Humayun Kabir, Secretary, Ministry of Education, Government of India, for their active help and support in bringing this Centre into being. The University has on its rolls 26 foreign students, 19 from countries of Asia and 7 from those of Africa.

By embarking on this project of an Asian-African Training Centre in Water Resources Development we are implementing the decisions reached at Bandung that, in matters of technical aid, economic and cultural co-operation and exchange of experience, the countries of Asia and Africa will be reaching out to each other, with the firm determination of benefitting by each other's experience on the basis of mutual co-operation, viewed in the larger context of world co-operation. The coming together of engineers from various parts of Asia and Africa will result in a pooling of knowledge and bringing forward problems from the various regions, in evolving the most satisfactory solutions to common problems, and in a correct appreciation of, and fruitful approach to, special problems of special regions. In this way many contacts will be established, new relations will emerge, the prejudices that have stood between country and country will be removed and new friendships and understanding will be forged. The combined technological knowledge of the various regions of Asia and Africa and their will to advance will be harnessed in helping forward the march of resurgent Asia and Africa towards self-sufficiency and freedom from social, economic and political bondage.

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Relative Place of Cement Concrete and Stone Masonry for Construction of Dams in India

By

C. L. HANDA, I.S.E., M.I.E.

Director, Bhakra Dam Designs Directorate

AUTHOR

During the past half a century a number of small and medium size dams have been built in India using either stone masonry or cement concrete or a blending of both. The factors that have influenced the selection of one or the other of the materials of construction in the past, as they will no doubt in the future, are :

(*i*) Economy
(*ii*) Size and height of dam
(*iii*) Availability of materials, labour and mechanical equipment
(*iv*) Requirements of strength of structure
(*v*) Requirements of permeability of structure
(*iv*) Time for execution.

Stone masonry has been successfully employed for the construction of low and medium height dams in the south and for weirs and diversion dams in the north. Concrete on the other hand, is being preferred for some major dams now planned or under construction in all parts of the country.

There is no doubt in my mind that cement concrete as a material of construction is much more suitable for construction of large dams in India, as compared to stone masonry. The reasons are given further.

All methods of design and analysis of arch and straight gravity dams consider these structures to be built of uniformly homogeneous elastic materials. Cement concrete, after it has set and hardened,answers this basic requirement better than stone masonry. Cement concrete also offers a flexibility in matters of strength, workability and water-tightness which stone masonry cannot provide. Composed of carefully selected stones, stone masonry is no doubt capable of strength characteristics comparable to that of well designed concrete. But the durability and strength of the mortar joints still remain a matter of theoretical conjecture. While it is possible to test cylinders of concrete to study their strength characteristics that will satisfactorily predict the behaviors of concrete under field conditions, it is not possible to test stone masonry in the laboratory to obtain reliable results. No practical technique has yet been evolved for this essential aspect.

Where the importance of the job or economy of the project demand a fast rate of construction, concrete will again be given preference over stone masonry. On a reasonably large scale, concrete can be mechanically manufactured, transported, placed and consolidated and at the same time uniformity of quality can be maintained.

Mechanizations of concreting operations does not necessarily mean the elimination of manual skills. On a job of reasonable size, a large force of workmen is required to fabricate, erect and clean the forms, sandblast and clean the construction joints. In addition a large number of skilled workmen are required to operate, repair and maintain the concreting equipment.

Cement concrete construction by mechanized methods demands higher skills and thus provides a better wage-scale for the workmen. Although a lesser number of men are employed on mechanised concrete jobs, the ordinary unskilled load carriers learn to handle formwork, sprayers or vibrators. Stone cutters and stone masons get equivalent, rather better, jobs in the manifold operations of concrete manufacture and placement. Over a period of 50 years there has not been much progress in the actual methods of hewing rock or placing stone blocks. Consequently the social status of the labourers or masons has not improved significantly.

On some of the jobs unit rate of concrete may be higher than that of stone masonry. The unit rate of concrete is generally higher due to the high cost of imported mechanical equipment. As our present projects progress and the concrete industry gets more mechanized operations of manufacturing and placing concrete will gain increasing popularity. The mechanical equipment will also appear to be less complicated. In time more and more of this mechanical equipment will be manufactured in India. I am confident that in the not-too-distant future concrete will be able to compete favourably in the matter of cost with stone masonry at most of the dam projects in India.

Earlier I have mentioned the flexibility obtainable in the design of concrete. It can be made more water tight, more durable, more workable with the use of entrained air, or cheaper with the use of pozzolanas. Stone masonry is a relatively inflexible material from the viewpoint of some of these aspects. In present day terms, one would consider stone masonry hardly capable of being codified within the processes of mathematical analysis. The design largely depends on the quality of stone economically available near

the site. There is hence relatively less scope in the design and for many of the improvements which are possible with concrete.

The height of dam is one of the important factors governing the choice of materials. All such and straight gravity dams higher than 200—300 feet range would be difficult to build with stone masonry. As the height increases, the unit rate of stone masonry increases considerably and its margin over concrete, if any, is nullified. It is quite unrealistic to say that by a mere increase in the number of workmen we can speed up masonry construction proportionately. There are severe limitations of space and the lift heights from which concrete is immune on account of the modern equipment for aggregate manufacture and concrete batching and mixing.

Finally, I would like to recommend a progressive attitude by the engineering profession in the matter of construction materials and methods. We in India, have already kept too long out of the "concrete era". Concrete is undoubtedly the material of the future. Higher gravity, arch and buttress dams which we are designing to-day are practicable only in terms of cement concrete. Thin arch and straight gravity dams designed in prestressed concrete are on the horizon and within the bounds of technological feasibility. Let us, therefore, think in terms of the modern material of construction—cement concrete. It is in this field, that advancements in design and manufacture are being made every day.

So far as stone masonry is concerned, we should study its characteristics on a scientific programme. Equipment needs to be evolved for performing strength tests on cement masonry blocks in the laboratory and the field. Some means are necessary for testing out cored samples of stone masonry and testing them to destruction under various conditions of loading. Based on these results our design criteria need to be evolved with due regard to the factor of safety which should make allowance for the non-uniformity in non-mechanized workmanship and the indisputable element of ignorance.

So far as comparative rates of masonry and concrete are concerned, any generalization will be misleading. The concrete rates are dependent on the availability within short lead of the stone aggregate and sand. The grading and quality of the aggregate are all important for strength. Then the size of the job and the degree of its mechanization are of paramount importance. In the case of stone masonry, the primary consideration is of the availability of masons of hereditary skill and experience. Engineers must steer clear of any non-scientific or propagandist attitude and leave the question of cost to be adjudged by the engineering head of the organization which is called upon to make a choice between the use of concrete or masonry.

The governing criterion will be the time available for the completion of the particular project and the set-up regarding men and machinery. If both concrete or masonry are suitable, the choice should be left to the preference of the engineering organization who has the responsibility of completing the project at a certain cost in a certain time. Due to any expressed difference in the opinions of technicians, the non-technical administrator or politicians feel at a loss in making a choice and a lot of irrelevant heat and controversy is brought into the issue. The time thus lost is a much bigger disadvantage than the choice of one or the other form of construction.

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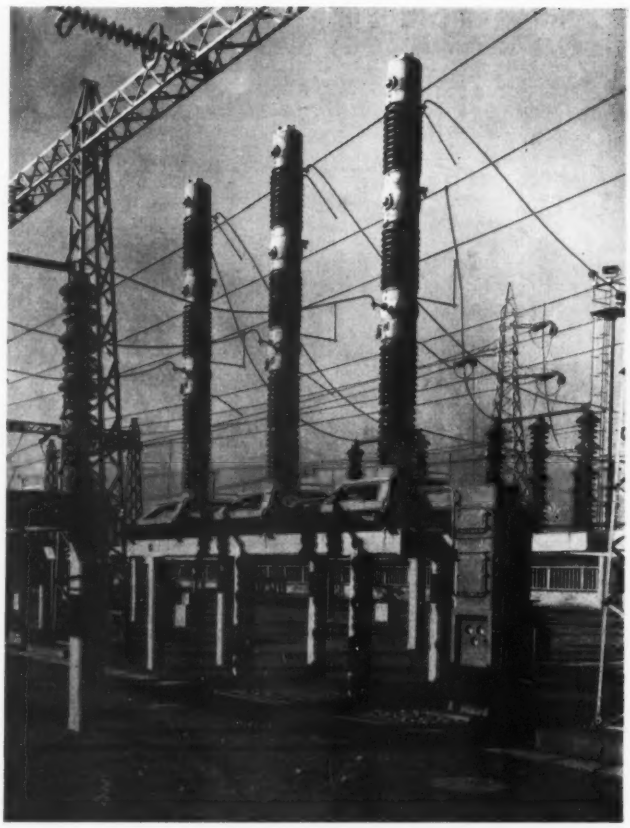

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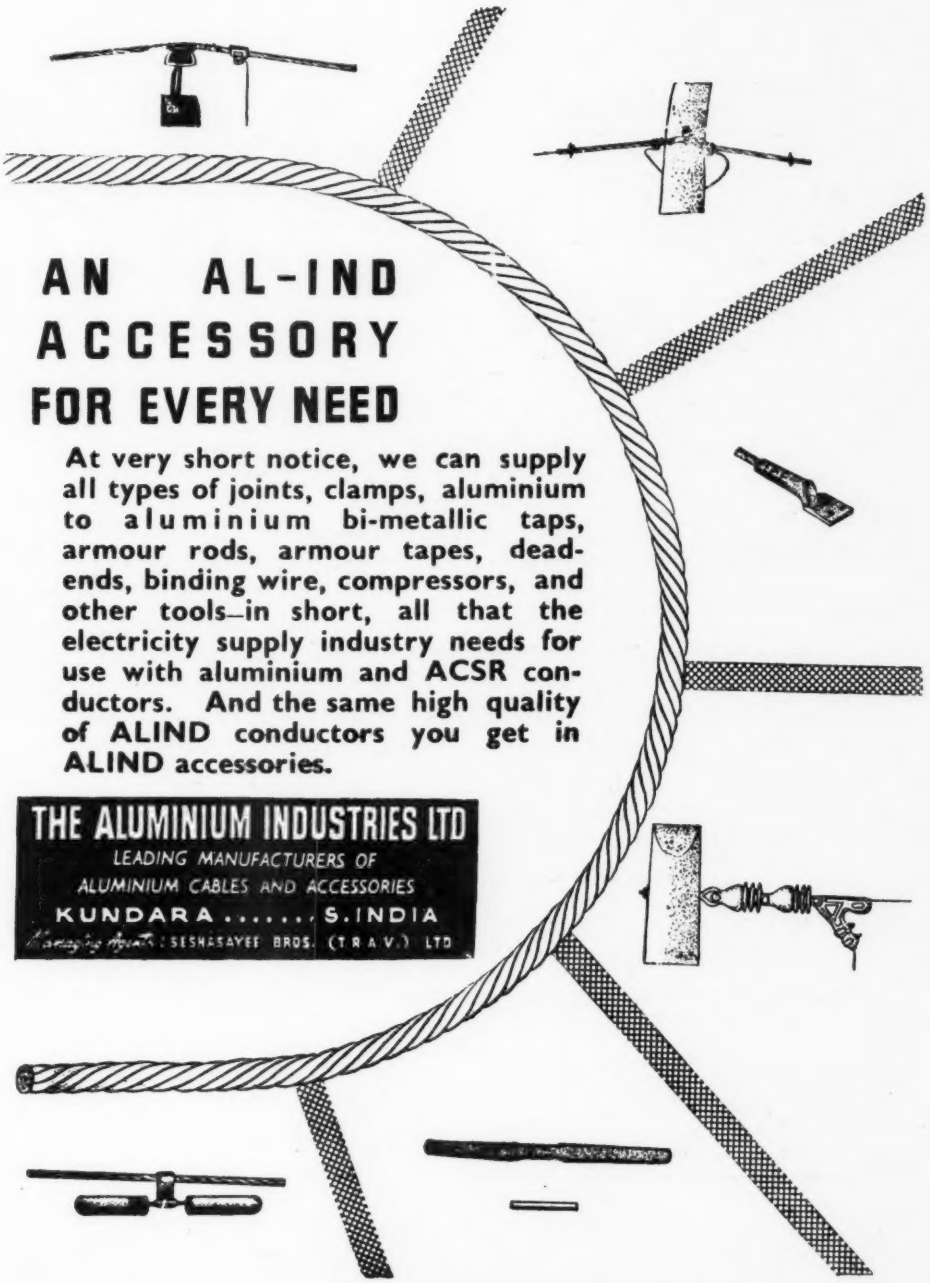

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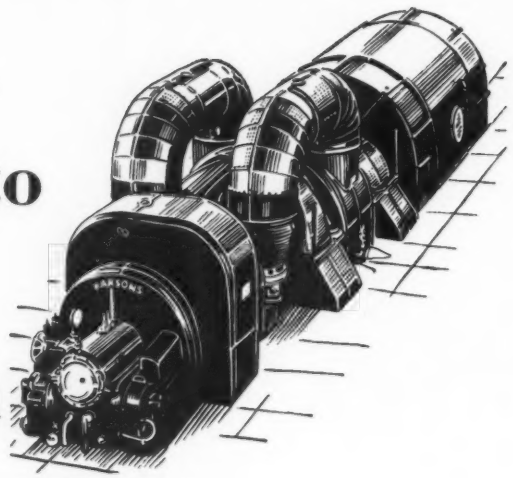

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MPCX 6

Coordination of Power Plant Capacity with Load Demand of a Power system

M. HAYATH

By

M. HAYATH, *Member (Hydro Electricity), CW & PC and* S. SWAYAMBU *Senior Project Officer, CW & PC*

S. SWAYAMBU

The problems confronting a power system engineer for planning and developing a large electricity supply system can be broadly divided into two sections, namely (1) phasing of power plant installations progressively and (2) optimum utilization of the available capacity by suitable methods of local promotion and reducing the interval between provision of generation capacity and its utilisation to the minimum practicable. The salient aspects of this important subject are set forth in this paper.

After the potential loads in an area have been surveyed, analysed and compiled into a forecast for a period of say, 10 years, the question arises as to how the generation and transmission capacity of the system could be planned in a coordinated manner. In the case of a new power system, which is intended to cover a larger area, the initial planning work is one of utmost importance. At a time when the country's capital resources have to be apportioned among a variety of beneficial projects, careful planning is necessary in order to avoid wasteful and uneconomic investment. Every project has its own limiting conditions and special requirements and these will naturally have to be considered in detail and dealt with according to their technical and economic merits. While it is difficult to enunciate any set rules or principles, it is intended to indicate here some of the special problems which are encountered in the planning of generation and transmission facilities for some of our projects, which may be kept in mind in our future work.

Load Demand and Firm Generating Capacity.

The broad objective in planning for the generating capacity in any system should be to prove for adequate firm capacity to meet the prospective system demand. The firm capacity of generating plant is usually reckoned after setting apart the largest machine as standby. In systems comprising a number of power stations, it would be necessary to exclude one or more machines but subject to a limit of about 15 to 20 per cent of the total installed plant capacity. In the case of large interconnected systems, however, there is scope for reducing the standby capacity to 10 to 15%. In addition, however, limitations due to boiler availability in thermal plants and the need for extra allowance for overhaul and inspection periods will have to be allowed in the case of steam power stations. In the case of hydro plants, due allowance will have to be made for seasonal variations in the water flow conditions and in the hydraulic head. These considerations will, however, call for a detailed computation for arriving at the firm demand and firm energy content of any system. In the case of combined hydro-thermal schemes, the estimation of the firm capacity becomes more involved and will have to be determined carefully taking all the variants into account.

Margin between System Load and Firm Capacity

The most important point in arriving at the requisite installed capacity of a system is in respect of the margin required between the system load and its firm capacity. Ordinarily the margin can safely be taken to be the amount of new load which would come up on the system during a period of time which will be required for the installation of additional generating capacity to meet that load. If it is a questing of adding a new thermal or hydro unit in an existing power station, period can be taken to be about 30 months based on present delivery periods for plants and machinery. For a new thermal scheme, a period of 36 to 42 months may be allowed and for a new hydro scheme the total period required is determined essentially by the extent and nature of major civil works, such as the dam, tunnel, etc. In order that the power system could be ready at all times to meet the growing demand of any area, this margin should be available, while work on the commissioning of more plant is in hand for a further period beyond the one for which the margin is available.

Phasing of Power Units

After the total firm and installed capacities required for meeting the loan requirements of a system have been decided upon it will be necessary to draw out a planned programme of power plant installations to cover a period of years on the basis of which the initial installation should be made. In many cases there is adequate justification for taking a reasonable long-term view of the power supply needs of a particular area. There are, however, some cases for which it would be prudent to plan for a limited period only in view of uncertainties of load growth, shortage of capital funds and other difficulties. In dealing with cases of either kind, it would, there-

fore, be necessary to make a detailed study of the requirements of each case and strike out a balance for arriving at the final plan. Let us assume that the load potentialities in an area to be served from a Central thermal station start with an initial load of 10 MW reaching upto 100 MW in 10 years with a more or less steady rate of growth. There are clearly two possible methods of planning for this project. The first is to install initially two sets each 30 MW capacity followed by two 50 MW sets at intervals of three years. The alternative scheme would consist of an initial installation of two 50 MW sets with a third 50 MW set at the end of five years. Either of the two schemes would bring in sufficient firm capacity to meet the load growth. However, as the system is a continuously expanding one with a steady growth of load with good prospects for accelerated growth in future years, there seems to be a definite advantage for going for the second alternative even if it would mean more capital outlay and provision for a larger percentage of standby plant in the initial years As large sized machines lend themselves for much higher pressure and temperatures and in turn give better operating economy the planning engineer should think in terms of larger unit sizes and take advantage of the modern developments in technological practice. The problem of fuel economy in India calls for particular attention as coal has to be hauled over long distances for most power stations. In the case of areas adjoining the coalfields, however, the utilisation of low grade coal in large power stations would be a logical step.

Unlike the above example, in an area where the load prospects are doubtful and will require to be slowly developed with special effort, it would be prudent to avoid over-capitalisation in the initial years. Poor returns over a number of years may bring forth adverse comment on the project planning. In such areas, a small increase in the rate level to consumers during the early years is not so important as the need for covering a wider area of supply with the capital funds available.

Side by side with planning for the generation capacity, transmission and distribution facilities will also have to be provided and in these cases the above points apply with equal force. It is well-known that the average cost of taking and serving one kilowatt of power to the ultimate consumer is much greater than providing one killowatt of generating capacity. Accordingly, the phasing of expenditure over transmission and distribution facilities has to be watched carefully so that these could be augmented from time to time at the proper points of load off-take rather than providing for it many years in advance of requirements.

Load Planning

Side by side with planning for the generation and transmission facilities the question of planning the load should receive attention. Although the initial forecasts of load usually make only a general assessment of the potentialities in any region, the detailed work in bringing the loads to fruition at the appropriate time is a great responsibility. Often the transformer capacities are being provided at various centres based on certain general impressions of load but this may not eventually materialise to the full extent with resultant loss of investment. Usually certain projected industries take as much time as the power system itself to install their own plant and equipment. In these cases it is very necessary to keep a close watch on the progress of the plans of such consuming industries. In other cases the power engineer may even have to exert his influence with Government and other circles to provide special facilities for the promotion and establishment of such industries. Also certain type of assistance which may be required by the consumers from a technical point of view of assurances in regard to availability or use of power will have to be rendered to the potential consumers. A proper approach to the tariff question will also be necessary to provide for incentives to special industries and to those which are changing over from own power generation to the public supply system. This process of simultaneous planning for load should receive greater attention in our utilities (many years in advance so that the further additions of generating capacities would be utilised to the fullest extent).

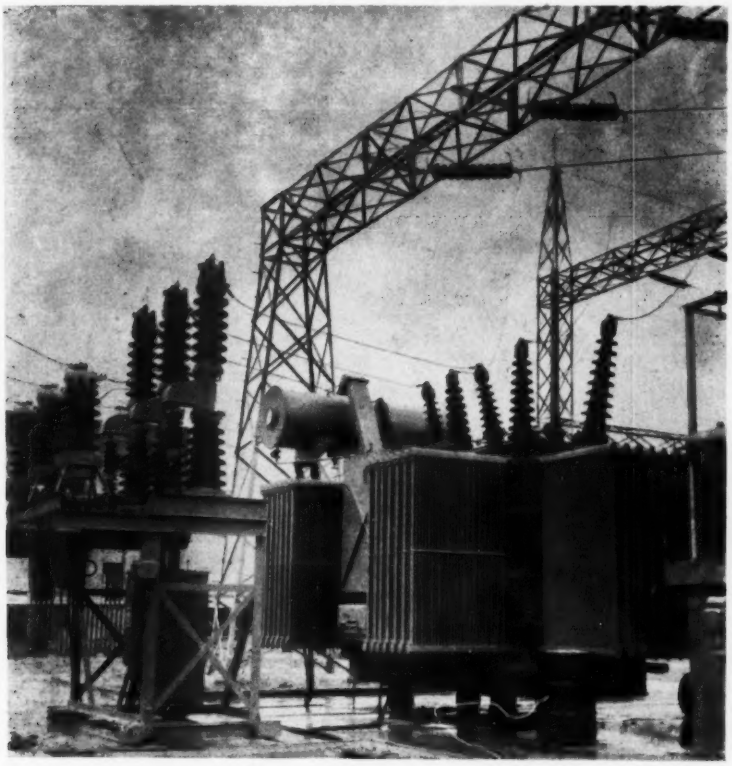
Building up of Optimum Load Curve and Using Secondary power

The power system engineer should also strive to build up as large a load factor on his system as possible so as to utilise the available peak capacity and energy content of the system to the best advantage. In order to do this, attractive terms may have to be offered to seasonal loads as well as those which work during system off-peak hours. Similarly, the question of utilizing the secondary power is a very important matter. Although such power is available in several systems in India, so far there are few cases where it has been possible to sell secondary power. Fortunately in some of our systems, the hydro-power has been firmed up to some extent by means of thermal combination. It is hoped, that in future steps would be taken to find ways and means of utilising secondary power. Often, special tariffs and promotional terms will have to be offered to industry if the system load has to be built to enable optimum exploitation of the generation sites.

Expansion of Power System

By its very nature any power system is an expanding one. There is nothing like a system reaching a level of saturation, at any rate in our country for a very very long time to come. The examples of utilities in Western countries have proved the above statement, because more and more uses for electricity are being developed every day and increased power demand follows in its wake. The same would apply to Indian undertakings particularly because we are at the very start of large-scale electrification. Even in our large cities the percentage of electrified houses is only a small fraction of the whole and as the standard of living of the people increases, more and more people would take to electricity. The work of a planning engineer does not stop after providing a certain amount of power plant capacity. It is only a beginning to build up more loads and thereby bring in more machines and lines into service. The planning for load and the planning for power supply, therefore, form a coordinated and a continuous process. The objective is not only to meet the load as it comes, but to build up the load by planned methods and service them by planned installations. It is outside the scope of this note to bring out the various practical methods by which load could be promoted in a power system but it is intended there

(*Continued on page* 16)



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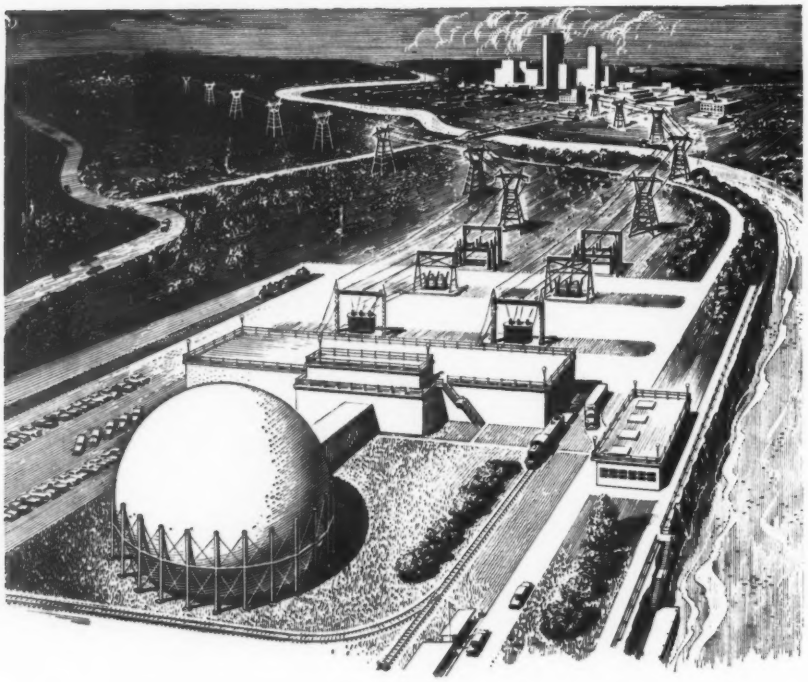

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Role of Forests in Flood Control

M. M. SRINIVASAN, I.F.S.

Central Silviculturist, Forest Research Institute

Forest plays a vital role in Nature by tending to moderate the extremes of climate conditions, preventing soil erosion and regulate the flow of stream. Destruction of forest cover in the past has led to serious consequences like floods, erosion, aridity impoverishment of soil and desiccation. "Cities and civilization have deteriorated and vanished as the year-long flows of usable water without which man cannot survive, first faltered and then failed through abuse of the hinterland of mountains and forests". (3) The occurrence of devastating flood with increasing frequency and intensity has therefore been responsible for stimulating the study of relationship between forests and floods and a good deal has been written on the subject.

Earlier literature on the influence of forests on climate and floods largely consists of casual observations, as there was little experimental evidence to go by. Serious experimental studies on the subject were started probably towards the end of the last century, and a considerable amount of research has been published, mainly in Europe and the United States of America. This has thrown valuable light on the interaction of the various factors involved so that we are now in a position of appreciate some aspects of this complex problem.

A flood in a stream is the result of the discharge of water beyond the carrying capacity of its channel. The contributory factors are (a) a heavy rainfall in the catchment area and the rapid drainage of this water, often coupled with the melting of snow which might have already been present there and (b) the silting up of the stream bed by deposition thereon of detritus brought down by the water itself from the catchment area higher up. The relationship between forests and floods has several aspects which can with advantage be considered under the following headings :—

(*a*) Influence of forests on precipitation.

(b) Influence of forests on loss of moisture by evaporation and transpiration.

(c) Influence of forests on surface run-off and seepage water.

(d) Influence of forests on soil erosion and the raising of stream bed down below.

Influence of Forests on Precipitation

Experimental work done on this subject deals mainly with the influence on rainfall of forests in restricted localities and pertains to the temperate regions. Some of the observations indicate that there is no essential difference in the quantum of rainfall over forests and in the open, but a larger number show that between sea and 3000 ft. in elevation, there is more precipitation over the forests, the excess varying from 1 to nearly 50 per cent (20). Some authorities (21) think that since forests, as compared with bareland or other type of vegetation, return a much larger proportion of rainwater to the atmosphere through evaporation and transpiration they must be contributing materially to inland precipitations. It is, however, generally accepted that forests do not appreciably influence precipitation associated with cyclones or strong seasonal winds. The influence of forests on the general pattern of rainfall in India, which is governed by the monsoons, is very doubtful and it would be safe to assume that forests probably do not appreciably influence the incidence of summer rainfall in our country.

Influence of Forests on Loss of Moisture by Evaporation and Transpiration.

The amount of water lost by the soil to the atmosphere in the form of evaporation varies with soil cover, temperature, atmospheric humidity, wind velocity and physical characteristics of the soil. Though difficult to assess accurately the loss of water from the soil through evaportion is much higher on bareland than inside a good forest. Land covered with other types of vegetation falls in between these two extremes. In this connection it may be mentioned that during light showers a portion of the precipitation is intercepted by the crowns which does not reach the ground as drip or flow along the steams and is returned to the atmosphere direct. Evaporation in this form accounts for the loss of a considerable portion of precipitation, especially in the case of light showers falling on dense canopied forest.

The transpiration loss depends upon the type, vigour and density of the vegetation, climate of the locality and the season of the year. It is nil on absolutely bareland and amounts to large quantities in the case of forests. According to Ney (18) the total amount of water transpired by a fully stocked beech forest during the growing season is equivalent to 10.8 inches, by spruce forest 8.3 inches and by Scotch pine forest 2.9 inches. Hoover (13) has placed the transpiration of deciduous forest in Coweeta, (N. Carolina, U.S.A.) at 17 to 22 inches of water. According to Griffith (12) the evapo-transpirational water loss in Utah (U.S.A.) is 10 inches on bare ground, 14 inches on herbaceous land and 17 inches on the aspen-herbaceous land. Not attempt has been made to determine the quantity of transpiration water for tropical conditions. It is safe to assume that these figures are considerably higher for the luxuriant forest vegetation in our areas of heavy rainfall. The depth up to which the soil is tapped for the transpiration water depends upon the type of vegetation it carries. In

general, it is greater in the case of trees and large shrubs and less for the smaller bushes, grasses and other herbaceous growth. While evaporation affects only a thin layer of soil at the top, transpiration affects the lower layers. Thus, during the dry season the surface layer is drier and the lower layers wetter in the case of bare or grass covered land than the corresponding soil layers in the forest. On the whole, forest soil is drier than bare soil of grass covered soils during the pre-monsoon and post-monsoon drought seasons. Studies carried out by Benskin (6) show that the moisture content of forest soils in Chhota Nagpur is much less than that of the adjoining bare-land. The difference between the two decreased during rains but was found to be appreciable even after heavy rain-storms. Forest vegetation thus acts as a pump sucking up water from the soil and losing it to the atmosphere through transpiration. It is for this reason that forest areas with high watertable develop into swamps as soon as the forest cover is destroyed.

Influence of Forests on Surface Run-off and Seepage Water

Precipitation that is not lost as evaporation or transpiration either flows down along the surface or sinks into the ground. The surface run-off water is a destructive agent, rushing down the slope to the stream and causing erosion on the way. As against this, the water sinking into the ground travels slowly underground through the mass of soil, being utilised by the plants for their growth replenishing springs and the underground reservoirs and providing a constant flow in the streams. The proportion of surface run-off to seepage water is governed by a number of factors, the more important of which are (a) the pattern of precipitation, (b) topography, (c) nature of soil and geology and (d) the character of vegetation. Out of these, man has full control over the character of vegetation and through this a partial control over the character of soil.

Forest helps in cutting down the proportion of surface run-off in a number of ways. In a dense multi-storyed forest canopy considerable period lapses before precipitation ultimately reaches the soil. The tangle of stems and roots of different types of plants present on the forest floor acts as a brake on the speed with which surface water moves, forcing it to go slower and by circuitous routes. The soil thus gets more time for absorbing water and the quantity of surface run-off is thereby proportionately reduced.

The mass of leaf-litter and debris, partially or fully decomposed, along with the mosses, lichens, and other herbaceous growth which characterise a good forest floor, receive even the heaviest downpour like a sponge. It sucks up and holds back a part of it and effectively protects the mineral soil against the denuding effect of the falling raindrops. It further keeps the surface pores open and leaves the capacity of the soil unimpaired to absorb water. The ability of the leaf-litter and debris to maintain the percolating capacity of the soil is far more important than their own absorbing ability (6.9.14).

The higher organic content of forest soils improves their physical texture and thus increases their power of absorbing and retaining moisture. A given volume of water takes much less time to seep into a forest soil than it does to seep into any other type of soil on account of its good physical condition. The rate of a absorbing water is particularly high in the case of a forest soil on account of the presence of channels and burrows formed by numerous forest fauna and the openings caused by decayed tree roots. According to Burger (7) a given volume of water takes less than one fifth the time to sink through a soil under forest than it would take to sink through a similar soil in the open. Bates (4) states that after a heavy rainfall, following the drought period, rain-water had percolated to depths of $8\frac{1}{2}$, 6, 4 and $1\frac{1}{2}$ inches in a woodland, a sod, a cornfield and a bare area respectively.

Forests not only protect the existing soil against erosion but also go on continuously adding to it. Soil under a set of climatic conditions is formed, through ages, as a result of the weathering of the parent rock. Through the decay of its products, vegetation plays a vital role in this process. It supplies carbon dioxide to acidify the soil, water and food to the myriads of soil microflora and fauna. The deep rooted trees and shrubs help to break the underlying rock through physical action of their root systems. The forest thus builds up and maintains a huge sponge-like reservoir of soil and sub-soil which absorbs a large portion of precipitation and gradually releases it in the form of clear water to the benefit of all.

Influence of Forests on Soil Erosion and the Raising of Stream Bed down below

A good forest cover creates ideal conditions for the rain-water to soak into and be retained by the soil. In the absence of forest cover the absorbing capacity of ground is greatly reduced. Water instead of being absorbed rushes along the surface, forming small rivulets the combine to form large torrents. During this process, valuable soil is eroded and the underground reservoir, which probably took ages to form, is soon permanently exhausted. So great is the force of this rushing water that it carries with it not only the finer particles of soil, but also billions of tons of coarser material, pebbles, small stones, boulders and huge pieces of rock. The eroded material swells the bulk of the stream and serves as a very efficient tool for cutting up and widening the channel in the hilly catchment area. As the slope eases off and the speed of rushing water arrested, the eroded material is gradually deposited in the stream bed. In the hilly, semi-hilly and *bhabar* zones it is primarily the coarser fractions which are sedimented, permanently ruining good agricultural lands and reducing the working life of the costly dams and reservoirs. The smaller fractions are deposited as the waters move more slowly along flat country. This accelerated sedimentation, by raising the stream bed forces the current to change its course at short intervals and is one of the most important causes of the frequent occurrence of high floods. It damages or renders useless the man-made masonry embankments and other protective structures and seriously adds to the cost of dredging operations.

Some Examples of the Influence of Different Types of Soil Cover on the Behaviour of Watersheds

Considerable amount of work has been done to evaluate the influence of different types of vegetation and leaf-litter on the proportions of surface and

sub-surface flows and the extent of erosion caused. A few outstanding examples are quoted below :—

(*a*) Bates and Zeasman (5) have estimated that the run off from a number of deciduous broad leafed forests on slopes averaging 36% amounted to 20% of the summer rainfall while in the case of cultivated fields under comparable conditions it averaged more than 25%.

(*b*) According to Lowdermilk (15) the surface run-off from burnt and unburnt plots in Chaparral (scrub) forests of Southern California is in the proportion of 3.6 : 1. Superficial run-off from the bare and burnt surfaces exceeds that from the latter covered surfaces by 3 to 30-fold and erosion by 50 to 6,000 fold.

(*c*) Meginnis (16) describing the results of an investigation on surface run-off and erosion for the Loessal uplands of the Mississippi catchment areas, has given the following figures of surface run-off and erosion for a locality with 180″ rain, 28% of which was in the form of torrential rainfall.

Type of Ground	*Surface Run-off*	*Erosion*
1. Cultivated cotton field with furrows up and down the slope	58%	100 tons per acre
2. Cultivated cotton field with furrows along the slope	74%	35 ,, ,, ,,
3. Barren land in an old field	48%	80 ,, ,, ,,
4. Unburnt broom sedge	Over 1%	Negligible
5. Oak forest	Less than 1%	,,

(*d*) Griffith (12) describing his impressions of an on the spot study of the watershed mangement research work in United States of America states that in the case of a typical watershed in the Coweeta Experimental Forest in North Carolina the Lower pasture land forming 20% of the total area and subjected to heavy grazing found to contribute 56% of the flood volume in the stream. On the other hand the contribution of 21% area under coppic forest was practically nil. The influence of various land uses on erosion may be guaged from the following figures :—

Types of Land Use	*Sediment*
1. Undisturbed forest	2 parts per one million
2. Forest with soil disturbed by intensive ogging	5000 ,, ,, ,, ,,
3. Normal pasture	400 ,, ,, ,, ,,
4. Mountain farming on steep slopes	6 pounds of soil per day per acre
5. Copper Hill bare soil	350 cubic yards per acre per year

Clearing of good forest land according to the local agricultural practices led to fall in yields from 24 bushels per acre to I bushel per acre in seven years. The soil losses started at 9 pounds per day and increased to 120 pounds per day during this period.

(*e*) Anderson and Trobitz (1) reporting the results of a study of a major flood producing storm have concluded that a decrease in forest cover significantly steps up peak discharges and deposition of sediment during major floods.

(*f*) Burger (7) reporting the results of the famous study into the water complex in the Emmenthal forest, Switzerland, for the period 1927-28 to 1941-42, concludes that under those conditions "100 m.m. of precipitation can infiltrate within 1 to 2 minutes into good forest soil whereas in the case of hard pasture soil it takes 1 to 5 hours. Within a good forest soil a precipation of 50 m.m. in 50 minutes is not followed by a measurable surface run-off while over pasture soil with a precipitation of 10. m.m there is a surface run-off of 30 to 40 per cent and with a precipitation of 50 m.m. a surface run-off of roughly 60%". Burger has further concluded that in the case of precipitations following wet weather, the maximum water level in the forested catchment is lower than that for the open grazing land by about 30 to 50 per cent or even more. It may be mentioned that the open grazing land was still covered with some vegetation. It was not comparable to our denuded and badly eroded slopes where the differences are bound to be even more pronounced.

(*g*) Dunford (9) reporting on a study concerning the influence of cattle grazing and timber land disturbances on run-off and erosion states that removal of leaf-litter increased surface run-off 7 times the normal rate and removal of trees and leaf-litter increased it up to 16 times. The slope in this case was moderate and the annual rainfall about 20 inches, the bulk of which being received in summer.

The amount of research work done in India on the various aspects of watershed management problems is very meagre. The role played by forests in our tropical climate with practically the whole of precipitation coming in the form of heavy storms in a period of about 3 months is bound to be much more important.

(*h*) Benskin (6) while discussing the effect of forests in stream flow with particular reference to the sal forests of Chhota Nagpur concludes "forests have a very marked effect on run-off, even more so here than in temperate climates". He found that the moisture content of the forest soil at the end of hot weather is much lower than the moisture content of bare soil. This This difference decreased during rains but is appreciable even after a heavy rain storm.

(*i*) Mobbs (17) has stated that after six years of strict protection of the catchment areas of a number of hill torrents threatening the lines of the Ganga and the Eastern Yamuna Canals it was found that the *raus* had decreased decidedly in breadth and the floods were spread over a longer period of time than before. He considered the retention of full forest cover in the catchment areas to be essential for reducing these hill torrents to their normal size.

(*f*) Gorrie (11) has summarised the results of two interesting experiments carried out by him in the Kangra and Hoshiarpur hills of Punjab as below. The first experiment was conducted during the period July to October 1937, while the second sought to study only individual floods on specific dates.

Kangra Nurpur Plots

Percentage of rain which ran-off	*Grass 80% cover*	*Grass and shrubs cover*	*Bare soil grass clipped every 3 days*
Out of total of 46 ins, on 32 wet days during July—Oct. 1937	7%	2.5%	25%
Out of total of 5¼ ins, in 4 hours, the heaviest single storm	2.2%	1.7%	6%
Weight of soil lost per acre :—			
Carried away on 32 wet days	3,500 lbs.	3,900 lbs.	18, 500 lbs.
Carried away by a single storm 5¼ ins.	260 lbs.	307 lbs.	3,511 lbs.

Hoshiarpur Polian Plots

Date	*Rainfall in inches*	*Duration of of Storms*	*Intensity in inches per hour*	*Run-off of rain (cubic cm)*			*Silt loss (gm)*		
				bushes	*grass*	*bare*	*bushes*	*grass*	*bare*
22-7-40	3.28	10 hours	0.32	1,350	12,200	14,525	7	18	95
1-8-40	2.67	6 hours	0.44	700	8,900	16,800	9	34	95
2-8-40	1.75	2 hours	0.88	425	8,625	10,500	5	17	41
8-8-40	1.71	1½ hours	1.14	925	7,150	8,700	13	22	40

These figures clearly bring out the influence of vegetation on run-off and soil wash.

Gorrie has also quoted Kirtikar's work in Sholapur (Bombay). Here on gently sloping fields (slope 1 in 85) and with a rainfall of 25″ falling in 41 rainy days the loss by run-off in the first half of the monssoon season was only 10 to 14% but rose to 24 to 34% in the latter half. Annual soil loss per acre worked out to 0.64 tons for grass, 18.04 tons for bare fallow without weeds, 30.19 tons for shallow cultivation and 43.99 tons for deep cultivation. Kirtikar calculated that under these conditions 8 inches of surface soil is lost in 20 to 54 years under different tyears of soil working as compared with 1384 years in the case of grass sod.

The above account shows that forests play a vital role in controlling floods. They maintain the water absorbing and retaining functions of the catchment areas at the highest pitch of efficiency and afford effective protection to the soil against erosion. Surface run-off is eliminated to a large extent and the water has to travel underground before it reappears in the form of springs and enters streams. As forest growth utilises a higher proportion of the precipitation water, the total discharge from a forested watershed is less and much more regulated than the discharge from other categories of land. Erosion is reduced to its geologic form resulting in slower sedimentation of stream channels and man-made reservoirs.

It is wrong to imagine that forests would totally prevent floods because floods are a geological phenomenon which occurred even before man started interfering with nature by destroying vegetative cover. It is equally wrong to believe that any system of reservoirs, dykes and dredging operations by themselves can result in permanent improvements. Afforestation, along with other correct land use practices, by forcing precipitation water to travel slowly below the surface and controlling its destructive force would certainly reduce the floods to their geologic norm and rob them of their present devastating character. These practices also stop erosion which means conservation of fertile soil at the source, protection of valuable agricultural land lower below, prolonging of the working life of costly engineering works, improvement of the natural water-ways and cutting down costs in dredging and flood relief operations.

Flood control works falls in two phases. The first, or the preventive phase lies in the hilly catchment areas. The operations will consist of afforestation of denuded areas, proper management of the existing forests and introduction of sound moisture and soil conservation practices on grazing and cultivated lands. The forester, the soil conservationist and the agricultural expert have to play their part here. The second phase starts as the stream leaves the hilly portion of its journey. The stress in this region will have to be on engineering works like storage reservoirs, protective embankments and dredging operations. The aid of vegetation will have to be sought here too in cutting down the costly brick and mortar embankments to the minimum and in reclaiming the land put out of commission through sedimentation.

These principles have been clearly recognised in the U.S. Flood Control Act of 1936 2(a) which has placed the operations in the catchment areas under the Department of Agriculture and those in waterways in the plains under the Army Department.

Effective mastery over floods would demand a proper co-ordination between the watershed and

waterway features of the flood control programmes. It is suioidal and highly wasteful to go ahead with the downstream flood control programmes and to embark on costly engineering works without paying adequate attention to the problems of watershed management. The root cause of the trouble lies primarily in the catchment area at the top and this region must receive early and adequate attention.

The importance of research into watershed problems in our country cannot be over-emphasized. The pattern of rainfall, the type of vegetation and agricultural and pastoral practices in the tropical climates, especially in thickly populated lands like India differ materially from the conditions in Europe and America. We have, therefore, to collect reliable information for our own conditions. We must possess full facts regarding the various aspects of this complex problem if we have to deal with it in a scientific manner. As already stated, practically the whole of research work done in this field pertains to the temperate climates. Research into the complex water. shed management problems is a long and laborious task It is imperative that we make a start on a large enough scale at the earliest possible date.

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(*Continued from page* 22)

The Dam between two Seas

some seven hundred years ago. The height of the closing dam is 24 feet 6 inches above normal sea-level, i.e., approximately 12 feet above the highest flood-level.

For the slopes of the dam 1,970,000 square yards of stone were used, and the building material includes 30,084,000 cubic yards of sand.

On top of the dam will be found a wide motor-road and a bicycle track and there is still room for another lane of motorcar traffic. A monument marks the place where the last gap of the dam was closed. It is 65 feet, 6 inches high and from it the visitor has a magnificient view of the North Sea, the Ijssellake, and the coasts of the provinces of North Holland and Friesland which are connected by the dam.

Locks for ships (2000 tons) and drainage locks will be found in the dam. They have been built in construction pits which were sunk in the open sea. The dam itself was built in the following manner : ships with trapdoors in the bottom marked the place for the dam with tons of gravel. Floating cranes then put on more gravel up to flood-level. The gravel was covered with sand and this foundation structure got layer upon layer of clay, upon which plates of zinc, slabs of basalt, and many other materials were placed to make the dam high and firm enough for its purpose.

It may be said that the Dutch Closing Dam is a miracle of engineering and ingenuity.

(*Continued from page* 10) **Coordination of Power Plant Capcity with Load Demand of a Power system**

to draw attention to the fact that constant effort and vigilance is required on the part of the power system engineer to ensure than anticipated loads come on the system at the proper place and time and that more and more loads should also be built up and means lack of thereby expand the system. A saturated system initiative on the part of power system engineer and the manager. For an expanding economy of the society which we serve, an active policy of development for both the load and the power plant capacity should go hand in hand.

It will be obvious from the foregoing that the task of planning, power generation and power utilisation will be continuous process and needs an effective machinery by which information relating to various aspects of the economic development in the country can be gathered, processed and maintained uptodate. Such comprehensive data will render the planning and execution of the various schemes relatively simple and straightforward. It is suggested that towards this purpose, the country should be divided into certain broad regions or zones, each of which should have a Standing Committee, its membership comprising the following officials :—

(1) A representative from the CW & PC.

(2) The Chief Electrical Engineer of the State or States, which come within the zone. (In the States where State Electricity Boards are functioning, the representatives of the Boards will take the place of the Chief Electrical Engineers).

(3) The Director of Industries of the State or States, which come within the zone.

Probably, it would be convenient to have four broad regions somewhat on the following basis :—

Region A : Comprising Travancore-Cochin, Madrsa Mysore, Coorg, Hyderabad and Southern half of Bombay State including the areas served by Tara-Central Railway-Bombay Covernment power stations.

Region B : Comprising northern half of Bombay, Madhya Pradesh, Madhya Bharat, Rajasthan (excluding Bikaner Division proposed to be served by Bhakra-Nangal system).

Region C : Comprising Andhra, Orissa, Bihar, West Bengal and Assam.

Region D : Uttar Pradesh, Delhi, Punjab, Pepsu, Bikaner Division of Rajasthan, Jammu & Kashmir.

It is expected that with the help of such Standing Committees it would be possible to obtain proper and timely apprisals of the power requirements and power possibilities of the various regions and positive steps can be taken to ensure the provision of necessary facilities in the matter of power development and power utilisation. These Standing Committees would, wherever necessary, initiate consultations with large private electricity supply undertakings, wherever they exist, and take into account their needs also in preparing their development plans.

Incidentally, it may be mentioned that the Central Water & Power Commission are shortly going to undertake comprehensive all-India load survey. In this task it is felt that these Standing Committees would be able to provide valuable information and assistance in the prosecution of the load survey work by the Central Water & Power Commission.

(*Paper read at the Third Engineeers' Seminar*)

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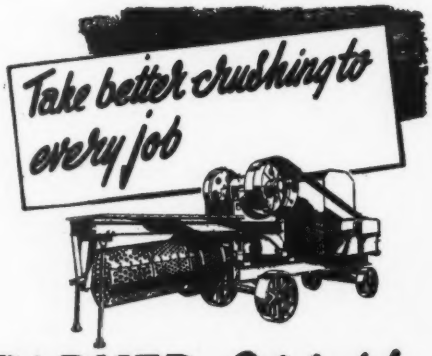

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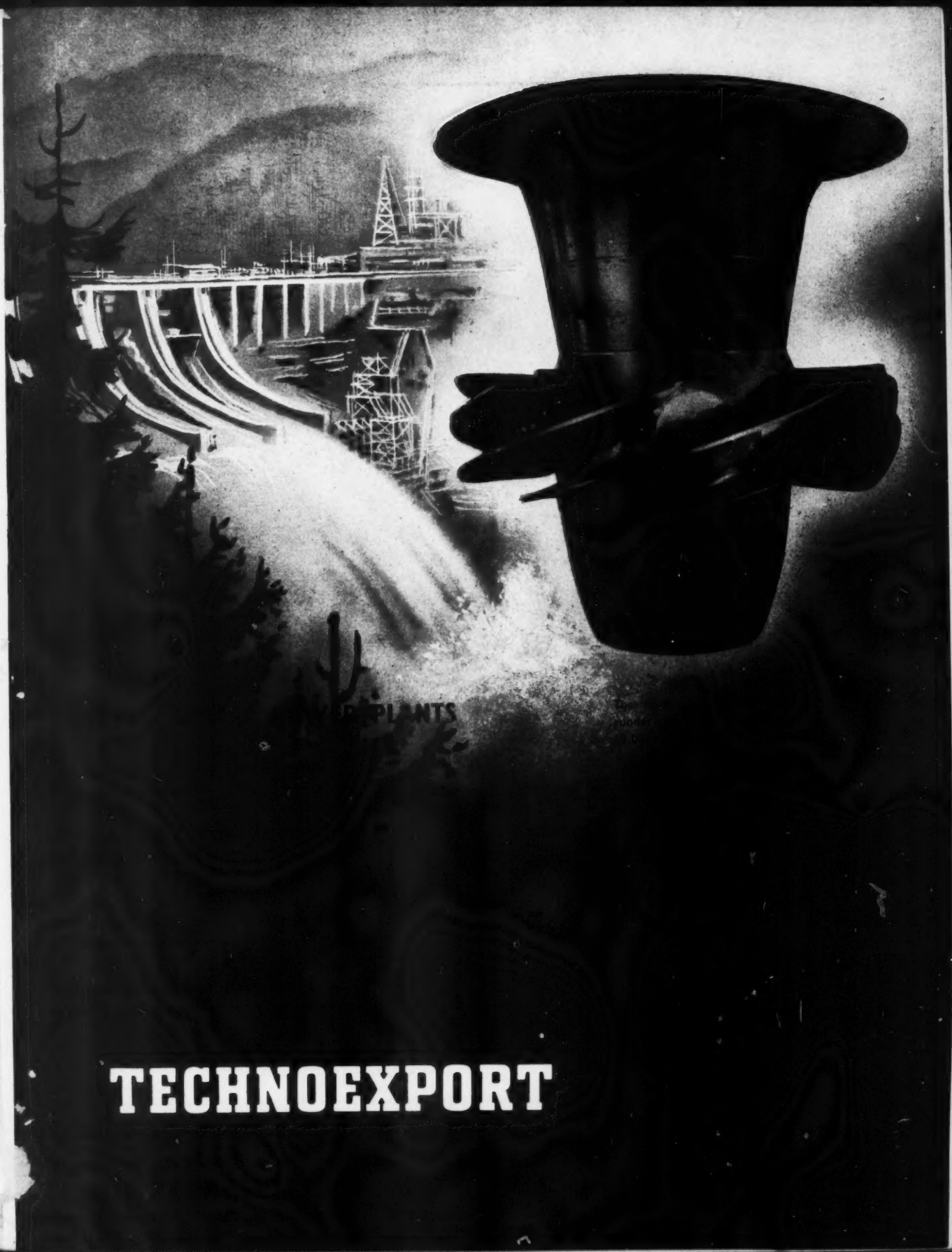
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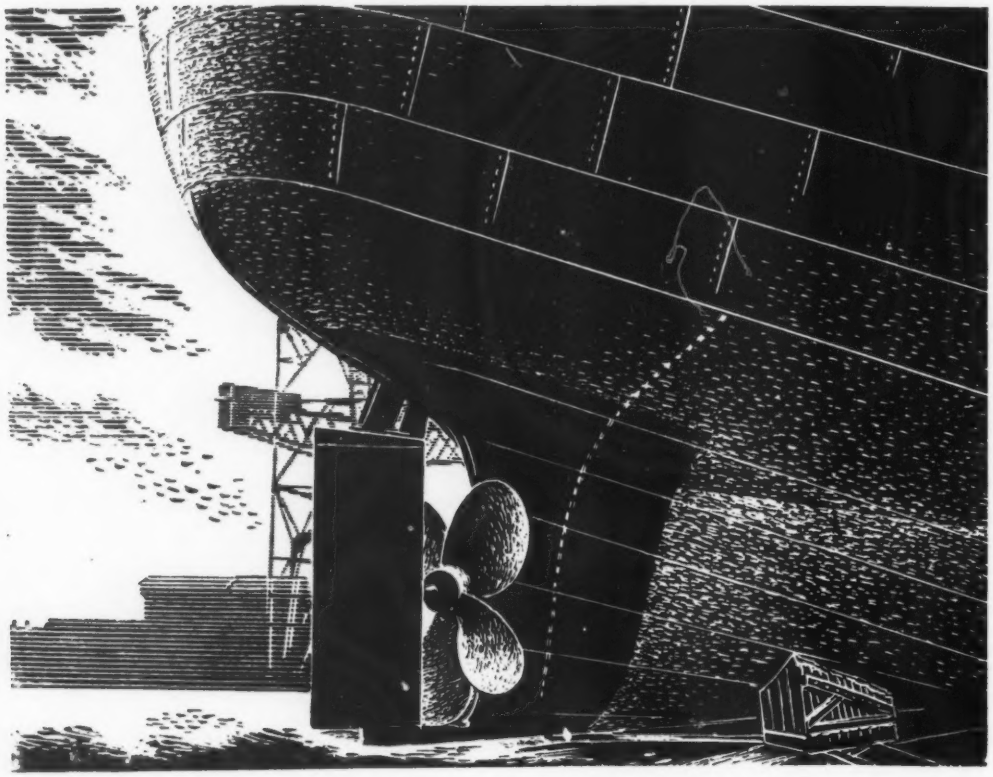

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IIX 53

Fluctuation of Ground Water-Table in the Lower Reach of Damodar

By

SATYAKAM SEN, M.A.

Vidyasagar College, Calcutta

AUTHOR

The part of the rainwater that soaks into the earth, under the present circumstances, is the main source of sub-soil water-supply. The location and movement of groundwater are largely determined by soil composition and geological formation. It is a known fact that perenial irrigation very often leads to water-logging. A good quantity of irrigation water in Punjab is lost by seepage from irrigation canals and reaches the underground water-table ; and even part of the water supplied to agricultural fields is not utilised by crops but goes down from the "Pellicular zone" to the "Capillary zone", and thus raises the water-table. This rise of the undergound water-table leads to water-logging and makes low-lying agricultural tracts uncultivable. The problem is sometimes being aggravated by construction of canals, embankments and fieldbunds for irrigation. In Punjab, according to the 1945 survey, the estimate of water-logged lands was about 50,257 acres.[1]

The study of Ground-water-table fluctuation in relation to the waterlogging problem of the Lower Reach of Damodar is very important.

Source Material

The Irrigation Dept. of the Govt. of West Bengal used to keep a record of the Pre-monsoon (April) and the Post-monsoon (Ocotber) depths of the water-table of open wells at selected places over the Lower Reach of Damodar. But these recorded observations do not give a complete picture of any long-trend fluctuations that occur because no continuous record for a single well or all the wells are available. Only a broad idea about short time fluctuations and the general nature of the water-table may be obtained from the accumulated data.

Recently D.V.C. has undertaken a scheme for water-table survey in the Lower Reach of the Damodar in order to study the present conditions of ground water-table. The schemes of water-table survey has been drawn up by D.V.C. and 30 piezometer tubes have already been sunk in April, 1954. The data from the piezometer observations have been received for our close examinations. Along with these, the analysis of the soil for different depths have also been obtained.

Trend of Fluctuations from Well Observations (1933-49)

The region concerned can be conveniently divided into three following zones from the observation of wells. The characteristic features are enumerated below :—

TABLE-A

Zones	*Area Served*	*Characteristic Features*	*Possibilities of Water Logging*
1.	Northern part of Howrah District beween River Damodar and River Hooghly	Shallow depth of water table from surface. In general, High water-table prevails ; little fluctuation between Pre & Post monsoon depth of water-table.	Chances of water logging
2.	S.E. of Burdwan-Kawa Rly Line-Jamalpur & Pandua P.S. of Hooghly Dist : Memari, Monteswar & Katwa P.S. of Burdwan Dist: Dead rivers of Behula & Gangur Passes through this tract.	-Do-	-Do-
3.	West & S. West of Burdwan-Katwa Rly line-P.S. of Ausgram., Mangolkot & Galsi of Burdwan.	The Ground-water table is well below the surface-level. Pre & Post-monsoon water-table fluctuation is very high.	Least possibilities of water - logging.

From the above table it is observed that in zones I & II water logging possibilities prevail and due to this, these zones require thorough investigation of ground-water-table fluctuations, so that it would be possible to demarcate correctly areas that are likely to be water-logged.

The rise of water table takes place with the monsoon rainfall. In June, following a long dry period, the water-table is at its greatest depth from the surface. In October, following the monsoon period, the water-table is at its minimum depth from the surface.

The Pre-monsoon & Post-monsoon fluctuations of water-table are well observed from the ground water contour map showing the differences of April and October water-table. (see map No. 2). The range is higher in the north-west and lower in the south-east. The fluctuation rate of ground water table is small between the Pre- & Post-monsoon periods in zones

I & II. The range of water-table rises high, as we proceed towards west and north-west, with the rise of relief. The variation of relief is slight between Damodar and Hooghly rivers.

Topography and Water-Table

Water-table fluctuation and the topographic features should be studied in detail in order to ascertain the actual water-logged areas. No piezometer station, which are under consideration, is situated 60 ft. high above sea level.

Slight topographic undulations or relief depressions with bad drainage conditions might lead to water-logging. The water-table is usually high near the river. This is possibly due to the supplies in the river being high during rainy season. The volume of water which overtops the banks and is being spilled, a large part of it, never returns. It remains standing in depressions and low-lying areas near the rivers.

Trend of Fluctuation from Piezometer Observations

Water-table fluctuations as observed from piezometer show that its rise and fall is well related to the rain fall. The data collection in the year 1954 started from the month of May, i.e., during the Pre-monsoon period.

Water-table fluctuation is very closely linked with rainfall. Its behaviour is of different kind in the Pre-monsoon, Monsoon and Post-monsoon periods. The records of the different water-table stations show that during monsoon the water-table rises, and reaches its peak about the early part of October. (i.e., at the end of the Monsoon period). In Post-monsoon season the water-table decreases steadily.

The data for 1955 reveal that in the month of June the water-table sinks to a low level. The data from the different water-table stations show close relationship in their rise and fall with the increase of rainfall. (see graphs figs. 4 to 6).

A maximum depth of water-table from the surface in D.V.C. commanded area is about 16 ft. and the minimum depth of water-table sometimes reaches ground level in the month of October after rainy season.

It may be noted that max. depth of water-table in the area under investigation does not exceed 20′ whereas in some parts of Burdwan, Bankura, the maximum depth of water-table is about 40′ to 45′.

Soil Features

The soil of the area, upto the depth of 50′ (see table C) under investigation, has been divided according to international value of the particle size classified by Prescott (3) and others. Clay, loam, and sand predominate in the area. Nature of sedimentation, as textural classification suggests that it is either slow or quick because coarse sand and clay deposition exists in most of the cases. Medium texture, i.e, silt plays a very minor part in the sedimentation in the Damodar-Bhagirathi interfluve.

Selected soil samples from all over the area have been tested for pH and show that a large majority of soils at the top surface have pH ranging between 6.5 and 7.5. Only in 2 places, Krishnarampur and Puinan (Hooghly dist.), pH recorded is slightly higher. In the above 2 stations the salt present in the soil is also high (1.65 and 1.72). The areas with high pH content and with high salt present in the profile points to a potential danger of alkalinasation at a subsequent stage if conditions remain favourable for such. It is interesting to note that in all the stations pH increases with the depth except two or three places, viz. (Bajemalia—Hooghly dist., Radhanagar and Gidhagram—Burdwan dist.). In these places, slight decrease of pH has been observed with the increase of depth. There are few stations where pH value remains more or less same with the increase of depth. (see fig. 3.)

TABLE-B

No	Stations	Height of the stations above M.S.L. approximately	Depth of W.T. 1954. Max. Depth below sur-face in April	Depth of W.T. 1954. Min. depth below sur-face in Oct	Depth of W.T. 1955. Max. Depth below sur-face in June	Depth of W.T. 1955. Min. depth below the surface in Oct
3	Denur	bet. 33-38 ft	15′ 1½″	6′ 4½″	16′ 2½″	5′11½″
21	Krishnarampur	10′	4′ 8½″	1′ 1½″	7′ ¼″	0′ 4″ (above
16	Puinan	32′	7′ 3½″	2′ 9½″	8′ 3″	4′ 2″ G.L.)
10i	Chaubera	40′	7′ 7¾″	1′ 8″	8′ 9½″	3′ 3¾″
10ii	do	40′	6′ 8¾″	0′ 0″	0′ 7¼″	
19i	Bajemelia	24′	9′ 5″	6′ 1″	10′ 0″	6′ 7½″
19ii	do	24′	6′ 9½″	1′ 4¾″	8′ 7¾″	0′ 9½″
2	Gidhagram	58′	12′ 7″		13′ 10¾″	4′ 6½″
5	Piplan	bet. 38-48′	8′11½″	0′ 3¾″	10′ 10″	2′11½″
4	Kalut	—	5′10½″	0′11½″	7′ 7¾″	3′ ½″
7	Sultanpur	—	8′ 8″	1′ 6½″	10′ 1½″	3′ 2½″
8i	Radhanagar	bet. 34-36′	7′ 9¼″	2′ 1″	8′ 5¼″	2′ 9½″
1i	Sudhpur	38′	6′¾″	—	66′11½″	0′ 3″
1ii	do	38′	6′ 5¼″	—	7′ 2″	0′ 4½″
17	Kalachara	32′	2′ 5¾″	0′ 6¼″	4′ 11½″	1′ 1″
15	Paunan	22′	3′ 3¾″	0′ 2¼″ (above G.L.)	4′ 6¾″	0′ 1¼″
27	Bhanjipur	36′	5′ 4¼″	1′ 3¼″	6′ 7¼″	1′11½″
18i	Brahmanpara	bet. 30-32′	8′11″	5′ 8½″	9′ 7½″	3′ 7½″
18ii	do	do	6′ 3″	3′ ½″	6′ 7½″	0′ 5½″
26i	Rajhati	bet. 28-30′	8′ 2¼″	4′ 4½″	9′ 6¾″	5′ 6″
26ii	do	do	5′11¼″	2′ 0″	7′ 1½″	1′ 4½″

TABLE C

Site No Sample No	Mouza, PS & Dist. (in serial order)	Soil Depth of Collected Sample	Texture of Soil*	Result of Analysis: Mechanical: Gravel	Coarse Sand 2·0-2 mm	Fine Sand 0·2-0·02 mm	Silt 0·02-0·002 mm	Clay <0·002 mm	Chemical: Total Salts	pH	Carbonate
1/1		0′ 0″-3′ 0″	Loam	0.4	7.1	46.5	25.6	18.4	0.01	7.6	Nil
1/2	Sudhpur,	6′ 11″-8′ 5″	Sand	0.4	40.8	54.7	0.9	2.8		7.9	Nil
1/3	Katwa	16′ 0″-18′ 4″	Silt loam	—	3.9	18.1	51.3	20.8		8.4	Trace
1/4	Burdwan	33′ 3″-36′ 4″	Heavy Clay	—	2.9	9.1	21.6	62.8		7.5	Nil
2/1	Gidhagram	0′ 0″-3′ 0″	Medium Clay	0.5	10.9	19.6	22.7	39.5	0.058	7.9	Present
2/2	Katwa	6′ 8″-8′ 10″	Medium Clay	0.7	6.7	24.4	19.9	46.0		7.5	Nil
2/3	Burdwan	22′ 0″-25′ 1″	Sand	10.2	75.9	6.3	0.9	6.3		6.9	Nil
3/1		0′ 0″-3′ 0″	Clay loam	0.1	17.1	27.5	27.0	23.0	0.016	7.5	Nil
3/2	Denur	7′ 5″-9′ 7″	Clay loam	5.0	31.7	15.8	13.6	31.3		7.8	Nil
3/3	Monteswar	13′ 6″-16′ 2″	Clay loam	0.2	39.5	19.4	13.2	26.2		7.1	Nil
3/4	Burdwan	26′ 5′-28′ 3″	Sand	1.5	65.0	21.8	1.6	9.1		7.1	Nil
4/1		0′ 0″-3′ 0″	Light Clay	0.3	5.4	27.6	25.2	40.0	0.036	7.7	Nil
4/2	Kulut	9′ 3″-13′ 6″	Light Clay	0.9	9.3	27.8	20.3	36.3		8.4	Present
4/3	Manteswar	16′ 2″-19′ 10″	Sandy Clay loam	—	31.4	36.7	6.5	22.3		7.1	Nil
4/4	Burdwan	28′ 2″-30′ 3″	Light Clay	0.2	2.7	21.8	31.4	37.8		7.5	Nil
5/1	Piplan	0′ 0″-3′ 0″	Clay loam	0.6	5.4	31.5	33.4	23·2	0.064	7.2	Nil
5/2	Monteswar	8′ 10″-10′ 10″	Clay loam	4.1	10.0	30.9	33.3	17.0		7.5	Present
5/3	Burdwan	29′ 11″-31′ 1″	Light Clay	0.6	7.3	27.2	23.2	38.1		7.5	Nil
6/1	Begpur	0′ 0″-3′ 0″	Medium Clay	0.2	0.6	11.7	41.7	42.0	0.06	7.6	Trace
6/2	Kalna	10′ 10″-13′ 3″	Medium Clay	0.4	6.0	18.9	25.9	42.1		8.0	Present
6/3	Burdwan	19′ 8″-21′ 4″	Medium Clay	1.1	7.1	21.4	21.6	42.7		8.2	Present
7/1		0′ 0″-3′ 0″	Sand	—	32.8	59.7	0.4	4.9	0.123	7.5	Nil
7/2	Sultanpur	9′ 4″-11′ 4″		—	1.0	12.2	39.4	34.6		7.1	Nil
7/3	Kalna	16′ 11″-20′ 4″	Light Clay	—	3.6	21.8	30.9	35.1		7.1	Trace
7/4	Burdwan	26′ 8″-29′ 11″	Medium Clay	1.6	4.5	19.8	24.2	42.5		8.5	Present
7/5		34′ 8″-37′ 10″	Medium Clay	—	12.5	15.4	26.3	39.8		7.8	Trace

Results obtained from :
Central Testing Laboratory (D.V.C.)
Maithon

N.B. Coarse Sand — 2mm—0.2 mm
Fine Sand —0.2 mm—0.02 mm
Silt —0.02 mm—0.002 mm
Clay — <0.002 mm.

* The classification of texture was carried out by the author on the lines indicated by Prescott *et al* (3)

There are 10 stations where salt content is more than 0.100. Out of these, in 4 stations salt present in the soil is above 0.150. (Krishnarampur, Puinan, Kotalpur—Hooghly dist., Akalpaush—Burdwan dist.) The percentage of salt present in the soil is found to be greater in the Hooghly district than elsewhere.

Carbonate is by far, the major chemical constituent present in the soil. In the upper surface, most of the stations show trace of carbonate, but in the middle and lower layers Carbonate is only sometimes present.

Probable Areas of Water Logging

Ground water slope from Arambag to Baidyabati (from well observations) shows that the water table (in October) approaches the ground surface as the ground surface slope decreases (See fig. 8). Near Gopalnagar as fall of surface level and the rise of October water table offers possibilities of water-logging. It clearly indicates (see table C) that the present water logged sites and non-water logged sites are occupied by clay and sandy soils. The present water logged sites are mainly found in the topographical depressions. As the general water table condition rises along with the rise of rainfall, the relief depressions may offer possibilities for future water logging sites. These depressions occur just along the fringe of the Bhagirati river and also particularly near the old and dead rivers.

Acknowledgement

The author desires to express his special debt of gratitude to Dr. N. K. Bose, Director, River Research Institute, West Bengal, for directing and conducting the work by many constructive suggestions. The author is also grateful to Shri. S. K. Nag, Ex-A.R.O., Model Research Station (Statistics), D.V.C. and his staff for their kind co-operation, assistance and offering scope for utilising statistics.

References

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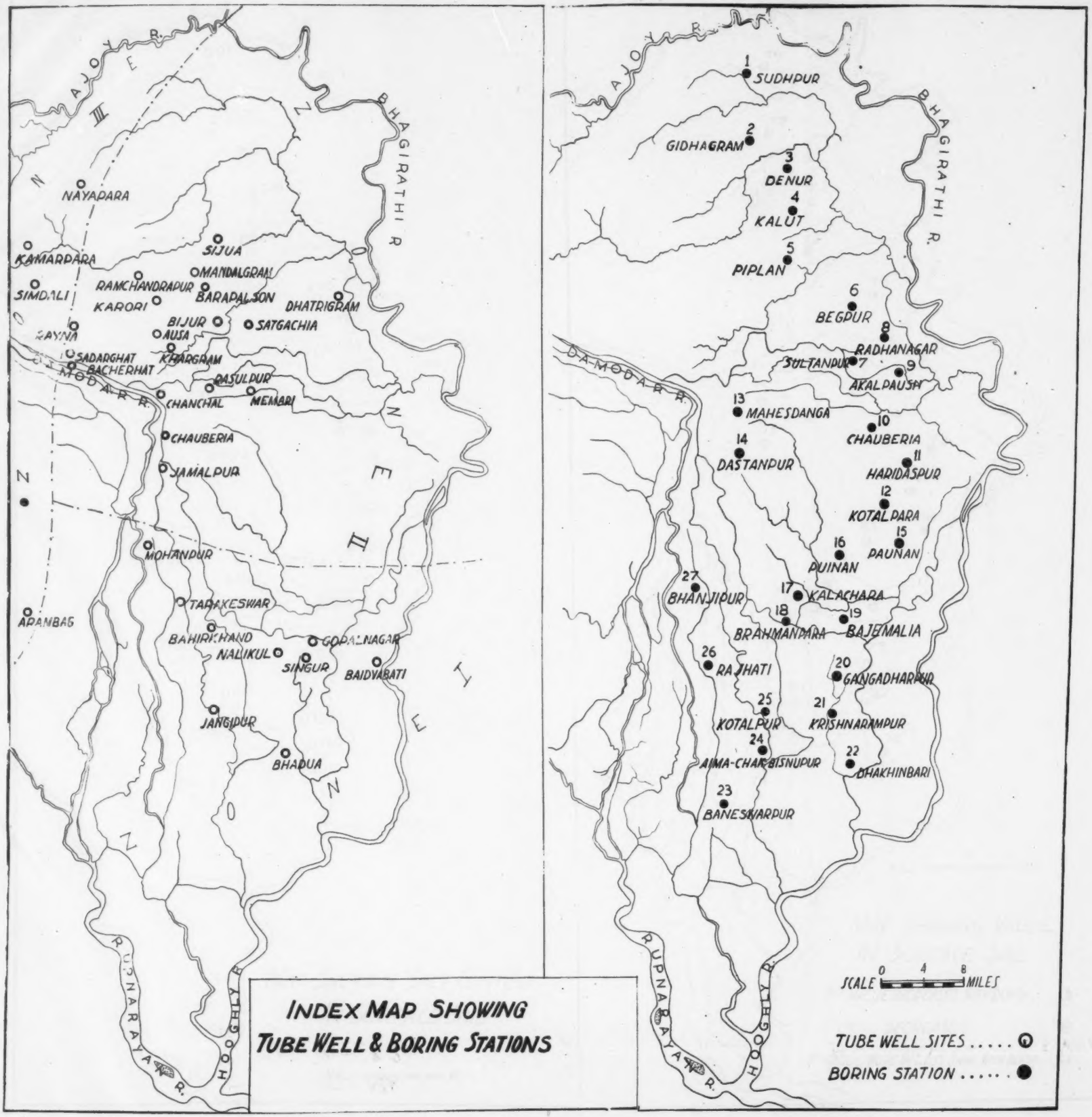
2. Bose, N.K. and Nag, S.K. : Fluctuations of Ground water-Table over D. V. Projects irrigation commanded area in Howrah, Hooghly and Burdwan districts of the West Bengal.
3. Prescott, J.A, Taylor, J.K. and Marshal, T.J. Trans. 1st com. Dut. See. Soil Sci. 1934. Cit, Piper, C.S. (Soil & Plant Analysis).

Site No Sample No.	Mouza, P.S. & Dist (in serial order)	Soil Depth of Collected Sample	Texture of Soil	Results of Analysis: Mechanical — Gravel	Coarse sand 2-0.2mm	Fine Sand 0.2-0.02 mm	Silts 0.02-0.002 mm	Clay <0.002 mm	Chemical — Total Salts	pH	Carbonate
8/1	Radhanagar	0′ 0″ - 3′ 0″	Light Clay	—	2·6	35·1	19·3	37·4	0·142	7·3	Nil
8/2	Kalna	10′ 0″ -14′ 0″	Sand	—	19·1	76·7	2·1	1·2		7·0	Nil
8/3	Burdwan	29′ 8″ -22′ 7″	Clay loam	—	24·1	21·6	15·9	33·5		6·8	Trace
9/1	Akalpaush	0′ 0″ - 3′ 0″	Medium Clay	—	1·6	20·2	29·7	41·3	0·182	7·3	Nil
9/2	Kalna	14′ 7″ -18′ 6″	Light Clay	—	1·2	22·2	31·6	35·7		7·5	Nil
9/3	Burdwan	26′10″ -27′ 6″	Medium Clay	—	3·3	25·6	21·0	45·2		8·4	Present
10/1	Chanbera	0′ 0″ - 3′ 0″	Silt loam	—	4·4	24·5	43·7	21·8	0·139	7·6	Trace
10/2	Pandua	10′ 6″ -12′ 5″	Clay loam	—	6·8	43·8	19·6	26·6		7·7	Nil
10/3	Hooghly	13′ 9″ -18′ 0″	Medium Clay	—	1·0	19·6	33·8	39·4		5·7	Nil
10/4		34′ 8″ -37′ 0″	Medium Clay	—	1·6	12·0	34·0	46·8		7.3	Trace
11/1	Haridaspur	0′ 0″ - 3′ 0″	Clay loam	0·3	1·8	40·6	27·6	26·6	0·073	7·8	Present
11/2	Pandua	9′ 9″ -11′ 8″	Clay loam	—	4·0	45·0	20·2	25·0		7·5	Nil
11/3	Hooghly	26′ 0″ -27′ 8″	Sand	0·2	32·0	62·0	0·5	2·5		7·8	Nil
11/4		42′ 6″ -45′ 2″	Sand	1·6	91·4	3·6	2·2	0·3		7·7	Nil
12/1	Katalpur Mahanad	0′ 0″ - 3′ 0″	Loam	(4·76-2·0 mm) 1·4	1·6	35·1	41·9	14·0	0·175	7·6	Nil
12/2	Polba	9′ 8″ -11′ 5″	Heavy Clay	—	0·5	5·8	30·9	56·5		6·8	Trace
12/3	Hooghly	30′ 0″ -32′ 2″	Light Clay	0·2	9·9	27·8	20·7	35·5		7·4	Trace
12/4		33′ 6″ -35′ 9″	Heavy Clay	0·3	2·2	19·9	24·6	47·3		8·4	Present
13/1	Maheshdanga	0′ 0″ - 3′ 0″	Loam	—	1·7	63·2	18·2	14·7	0·038	7·5	Nil
13/2		9′ 5″ -13′ 0″	Clay loam	—	5·8	49·1	18·3	22·2		7·1	Nil
3/3	Memari	23′ 3″ -25′ 8″	Clay loam	—	10·9	18·6	31·6	30·3		8·0	Present
13/4	Burdwan	34′11″ -37′ 8″	Sand	0·5	79·1	15·4	0·8	3·8		7·5	Nil
14/1	Dastanpur	0′ 0″ - 3′ 0″	Clay loam	0·3	23·5	25·5	17·9	17·2	0·022	7·5	Nil
14/2	Jamalpur	8′ 8″ -11′ 9″	Medium Clay	0·2	20·2	14·0	18·8	41·7		7·4	Nil
14/3	Burdwan	16′ 4″ -18′ 3″	Clay loam	0·4	40·4	22·7	8·8	24·5		7·4	Nil
14/4		22′ 3″ -24′ 1″	Sand	4·6	78·5	8·5	2·7	4·6		7·4	Nil
14/5		31′ 2″ -33′ 5″	Medium Clay	0·3	16·0	19·2	18·2	39·6		7·7	Nil

Site No Sample No	Mouza P. S. & Dist. (in Serial Order)	Soil Depth. of Collected Sample	Texture of Soil	Results of Analysis: Mechanical — Gravel	Coarse Sand 2-0.2 mm	Fine Sand 0.2-0.02 mm	Silts 0.02-0.002 mm	Clay 0.002 mm	Chemical — Total Salts	pH	Carbonate
15/1		0′ 0″ - 3′ 0″	Clay loam	—	2.7	23.3	35.7	30.8	0.058	8.4	Not found
15/2	Paunam	8′ 6″ -10′ 6″	Clay loam	—	9.7	29.9	32.1	26.2		7.2	Not found
15/3	Polba	17′ 6″ -19′ 5″	Heavy Clay	—	0.9	8.7	28.1	54.0		7.7	Not found
15/4	Hooghly	26′ 9″ -28′ 9″	Light Clay	—	3.7	15.7	20.7	48.4		8.4	Present
15/5		33′ 7″ -35′ 2″	Clay loam	—	8.0	26.3	25.1	34.4		8.2	Present
15/6		38′ 5″ -39′ 9″	Clay loam	4.76—2 mm	7.9	20.5	19.1	30.9		9.0	Present
16/1	Puinam	0′ 0″ - 3′ 0″	Clay loam	—	2.8	45.3	22.2	25.3	0.172	8.3	Not found
16/2	Polba	11′ 1″ -13′ 8″	Medium Clay	—	1.6	15.9	31.6	43.3		7.1	Present
16/3	Hooghly	13′ 3″ -15′ 0″	Heavy Clay	—	1.6	13.5	28.3	51.0		6.8	Not found
16/4		33′ 0″ -34′ 1″	Sand	—	64.2	22.9	2.6	8.3		8.4	Present
16/5		36′10″ -38′ 3″	Light Clay	—	6.3	23.3	24.8	38.7		7.7	Present
17/1	Kalachara	0′ 0″ - 3′ 0″		—	5.4	21.7	27.5	34.0	0.086	7.7	Not found
17/2	Haripal	11′ 7″ -15′ 3″	Heavy Clay	—	1.5	17.2	19.8	53.2		7.1	Not found
17/3	Hooghly	18′ 1″ -20′ 2″	Medium Clay	7.3	4.7	16.0	18.7	46.5		8.2	Present
17/4		31′ 3″ -34′ 1″	Medium Clay	—	6.3	19.7	24.3	45.2		7.8	Present
18/1	Brahmanpara	0′0″- 3′ 0″	Sand	—	46.3	36.3	4.6	10.1	0.124	7.3	Not found
18/2	Haripal	9′ 6″-14′ 8	Sand	—	92.8	5.0	0.1	1.7		7.8	Trace
18/3	Hooghly	18′ 0″-19′ 5″	Heavy Clay	—	1.8	10.6	26.6	55.6		7.3	Present
18/4		32′11″-34′ 0″	Silt loam	—	2.3	15.7	49.5	27.8		8.3	Trace
19/1		0′ 0″- 3′ 0″	Clay loam	—	0.9	51.1	24.0	20.7	0.072	7.7	Not found
19/2	Bajemelia	19′ 0″-24′11″	Sand	—	79.7	10.4	2.5	1.9		7.5	Not found
19/3	Singur	25′ 2″-27′ 1″	Medium Clay	—	3.7	20.8	25.4	46.0		7.6	Not found
19/4	Hooghly	30′ 0″-32′ 2″	Light Clay	—	4.3	32.6	20.2	37.4		7.5	Present
19/5		43′ 2″-45′ 6″	Clay loam	—	1.2	30.7	39.3	24.2		7.7	Not found
19—(ii) 1	,,,,	14′ 4″-16′ 3″	Clay loam	—	5.0	42.1	29.7	18.2		6.9	Nil
20/1	Gangadharpur	0′ 0″- 3′ 0″	Clay loam	—	0.3	49.9	25.8	20.1	0.074	7.3	Not found
20/2	Chanditala	15′ 3″-17′ 3″	Medium Clay	—	1.8	18.5	28.6	45.7		7.8	Not found
20/3	Hooghly	33′ 2″-36′ 2″	Medium Clay	—	9.3	22.6	20.0	42.2		8.4	Present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DAMODAR R.
HOOGHLY R.
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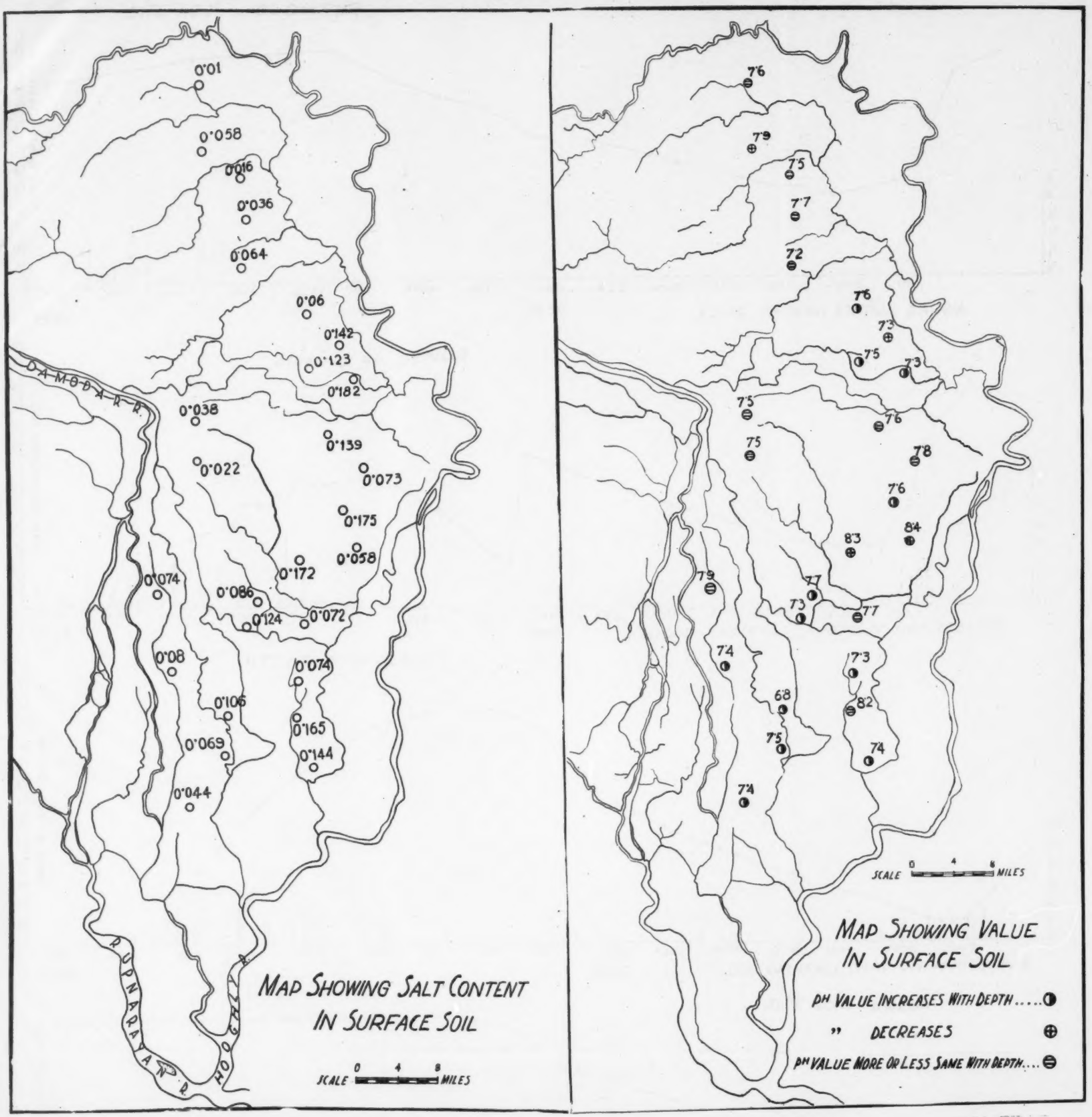
NAYADARA
KAMARDARA
SIJUA
MANDALGRAM
SIMDALI
RAMCHANDRAPUR
BARAPALSON
DHATRIGRAM
KARORI
BIJUR
SATGACHIA
AUSA
KHARGRAM
SADARGHAT
BACHERHAT
DASULPUR
CHANCHAL
MEMARI
CHAUBERIA
JAMALPUR
MOHANDUR
TARAKESWAR
ADANBAG
BAHIRKHAND
GOPALNAGAR
NALIKUL
SINGUR
BAIDYABATI
JANGIPUR
BHADUA
1 SUDHPUR
2 GIDHAGRAM
3 DENUR
4 KALUT
5 PIPLAN
6 BEGPUR
7 SULTANPUR
8 RADHANAGAR
9 AKALPAUSH
10 CHAUBERIA
11 HARIDASPUR
12 KOTALPARA
13 MAHESDANGA
14 DASTANPUR
15 PAUNAN
16 PUINAN
17 KALACHARA
18 BRAHMANPARA
19 BAJEMALIA
20 GANGADHARPUR
21 KRISHNARAMPUR
22 BHAKHINBARI
23 BANESWARPUR
24 AIMA-CHAR-BISNUPUR
25 KOTALPUR
26 RAJHATI
27 BHANJIPUR
I
II
III
SCALE 0 4 8 MILES
INDEX MAP SHOWING
TUBE WELL & BORING STATIONS
TUBE WELL SITES .....
BORING STATION .....

Figure 1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0·08
0·074
0·106
0·165
0·069
0·144
0·044
DAMODAR R.
RUPNARAYAN R.
HOOGHLY R.
MAP SHOWING SALT CONTENT IN SURFACE SOIL
SCALE 0 4 8 MILES
7·6
7·9
7·5
7·7
7·2
7·6
7·3
7·5
7·3
7·5
7·6
7·5
7·8
7·6
8·3
8·4
7·9
7·7
7·3
7·7
7·4
7·3
6·8
8·2
7·5
7·4
7·4
SCALE 0 4 8 MILES
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pH VALUE INCREASES WITH DEPTH .....
" DECREASES
pH VALUE MORE OR LESS SAME WITH DEPTH....

Figure 3

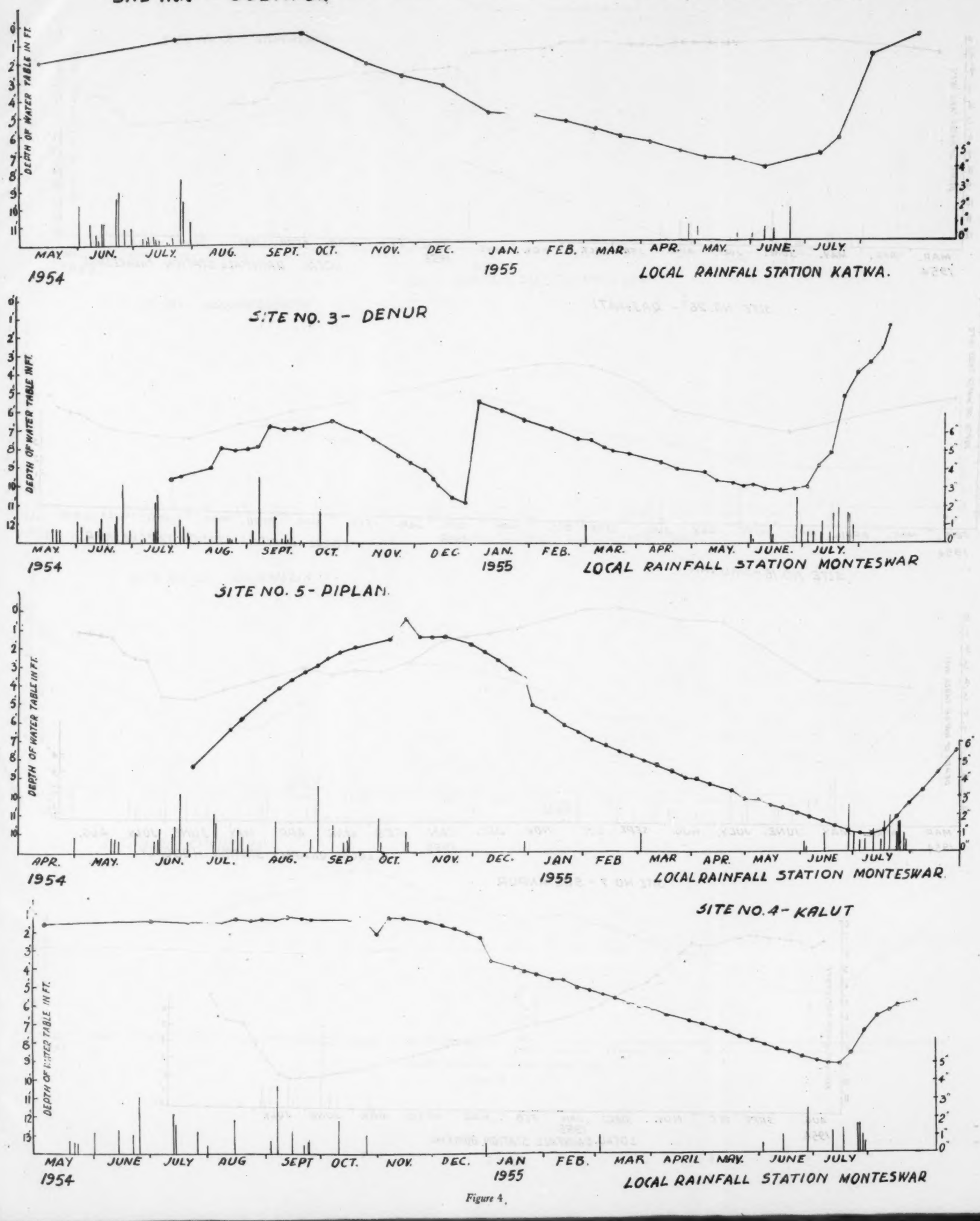
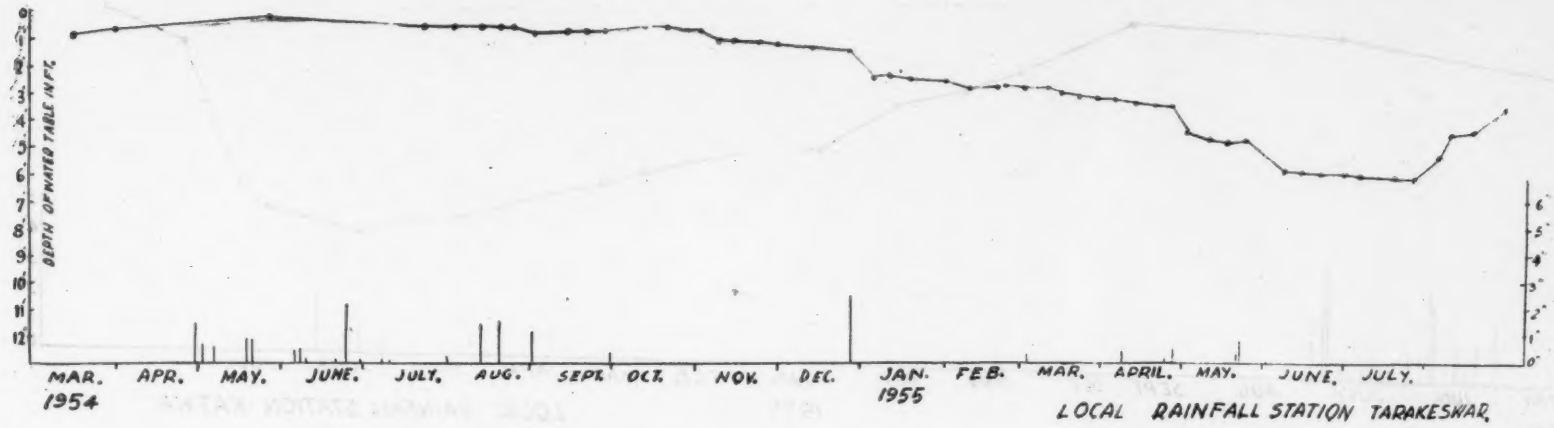
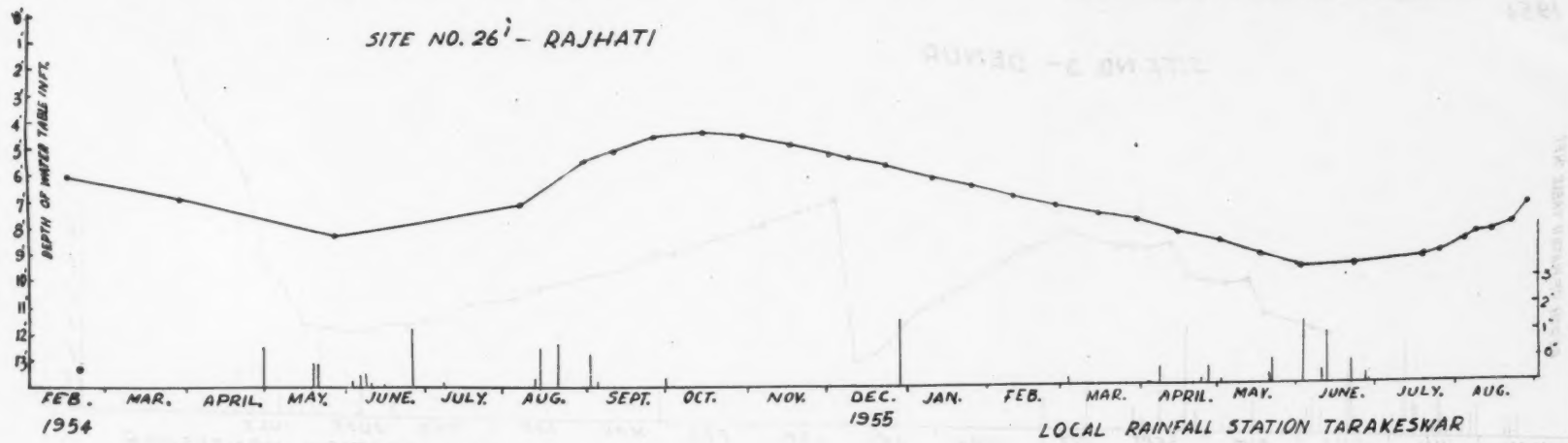

SITE NO. 1i - SUDHPUR
DEPTH OF WATER TABLE IN FT.
MAY. JUN. JULY. AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY. JUNE. JULY.
1954
1955
LOCAL RAINFALL STATION KATWA.
SITE NO. 3 - DENUR
DEPTH OF WATER TABLE IN FT.
MAY. JUN. JULY. AUG. SEPT. OCT. NOV. DEC. JAN. FEB. MAR. APR. MAY. JUNE. JULY.
1954
1955
LOCAL RAINFALL STATION MONTESWAR
SITE NO. 5 - PIPLAN.
DEPTH OF WATER TABLE IN FT.
APR. MAY. JUN. JUL. AUG. SEP OCT. NOV. DEC. JAN FEB MAR APR. MAY JUNE JULY
1954
1955
LOCAL RAINFALL STATION MONTESWAR.
SITE NO. 4 - KALUT
DEPTH OF WATER TABLE IN FT.
MAY JUNE JULY AUG SEPT OCT. NOV. DEC. JAN FEB. MAR APRIL MAY. JUNE JULY
1954
1955
LOCAL RAINFALL STATION MONTESWAR

Figure 4.

SITE NO. 17 - KALACHARA



SITE NO. 26 - RAJHATI



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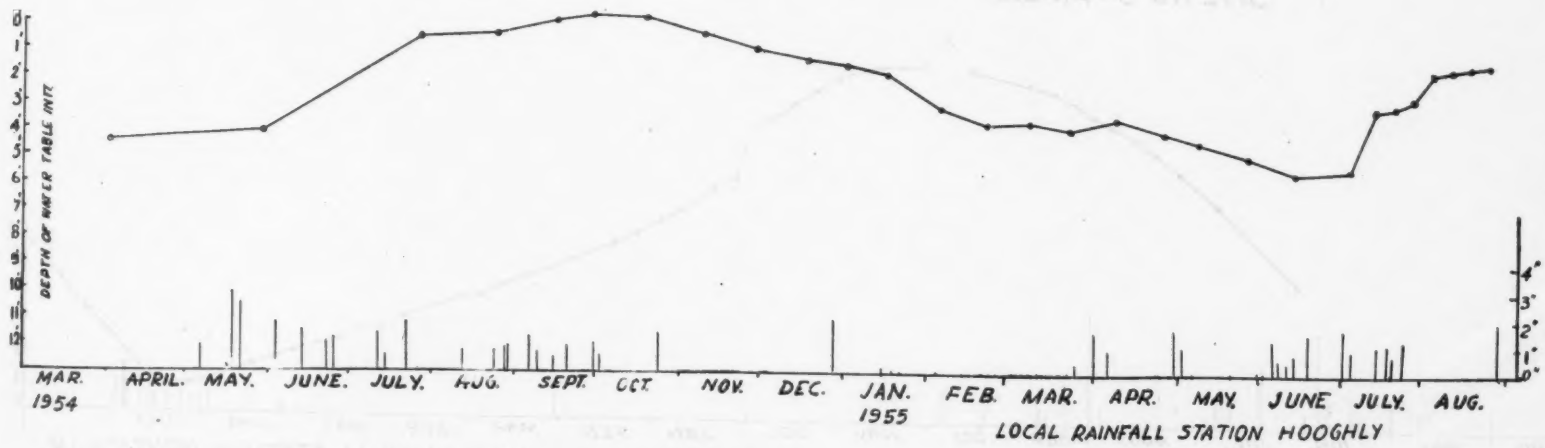

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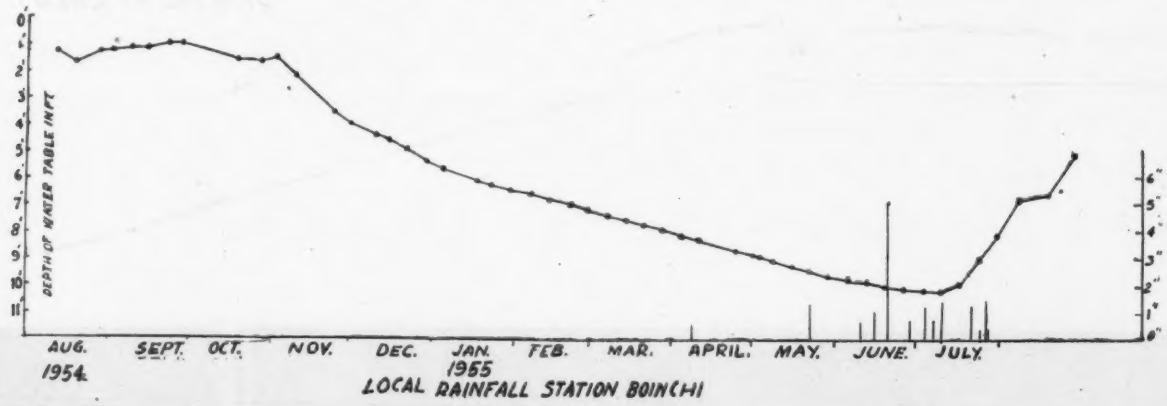


Figure 5

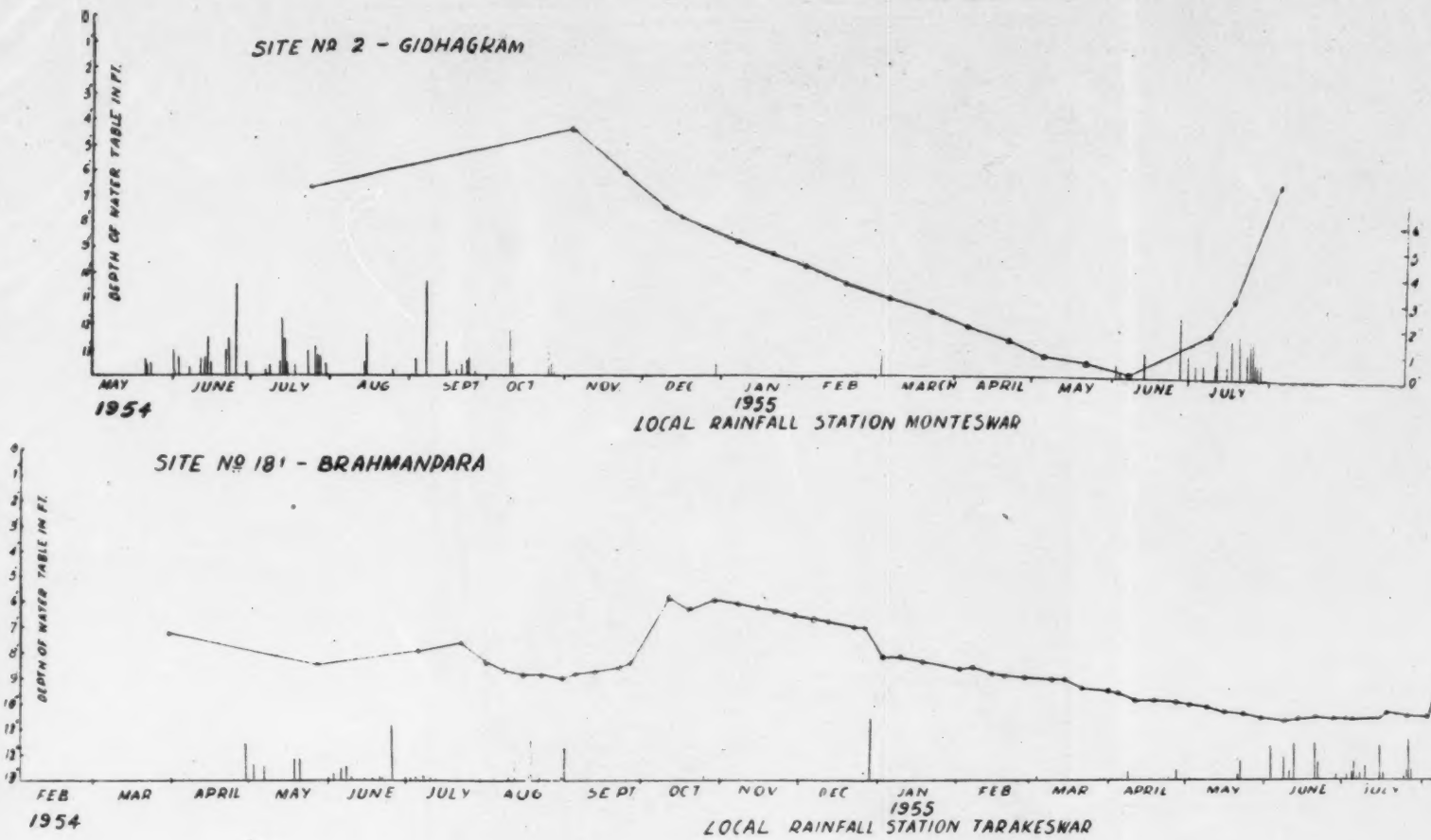

SITE Nº 2 - GIDHAGRAM
DEPTH OF WATER TABLE IN FT.
MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MARCH APRIL MAY JUNE JULY
1954
1955
LOCAL RAINFALL STATION MONTESWAR
SITE Nº 181 - BRAHMANDARA
DEPTH OF WATER TABLE IN FT.
FEB MAR APRIL MAY JUNE JULY AUG SEPT OCT NOV DEC JAN FEB MAR APRIL MAY JUNE JULY
1954
1955
LOCAL RAINFALL STATION TARAKESWAR
SITE Nº 19i - BAJEMELIA
DEPTH OF WATER TABLE IN FT.
MARCH. APRIL. MAY. JUNE. JULY. AUG. SEPT. OCT. NOV DEC JAN. FEB. MARCH. APRIL. MAY. JUNE. JULY.
1954
1955
LOCAL AREA RAINFALL
SITE Nº 10i - CHAUBERA
DEPTH OF WATER TABLE IN FT.
RAINFALL
APRIL MAY JUNE JULY AUGUST SEPTEMBER OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY
1954
1955
LOCAL RAINFALL STATION BOINCHEE

Figure 6

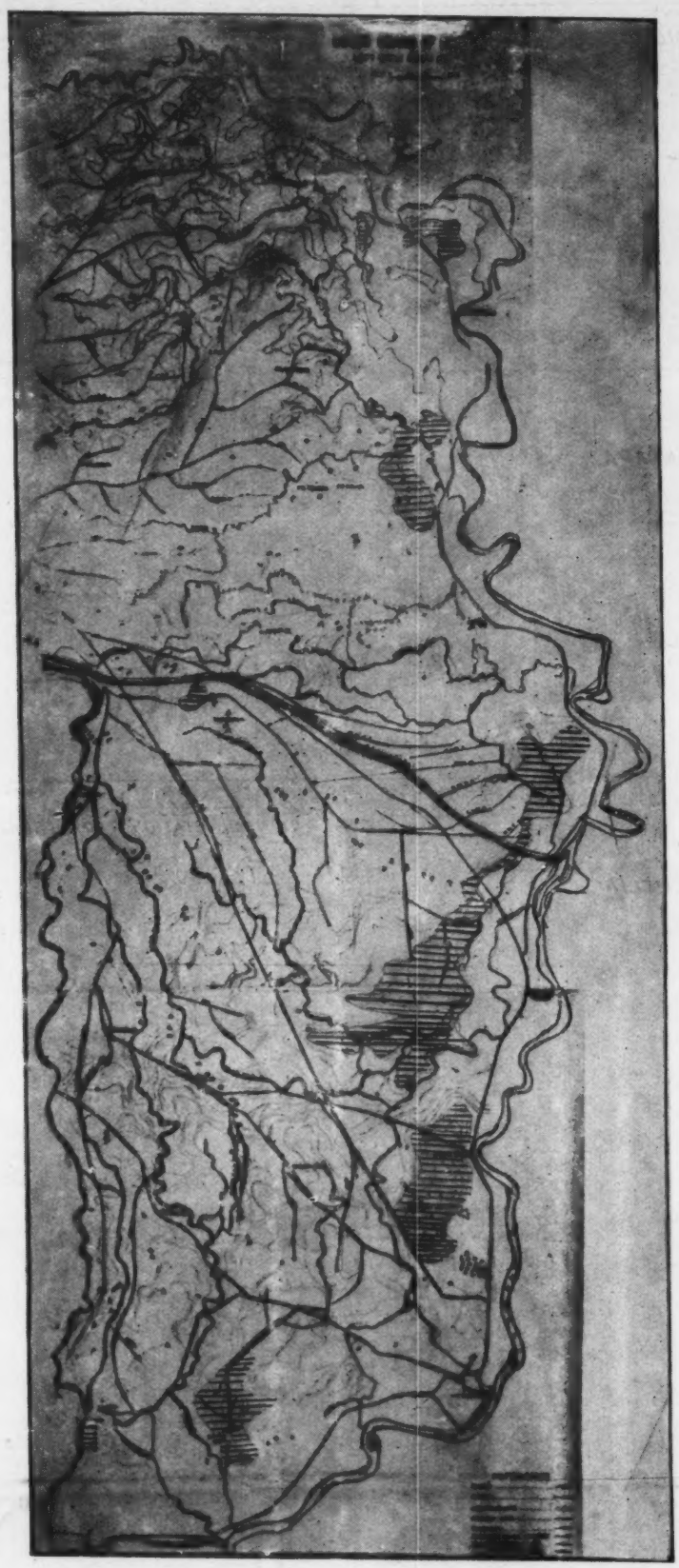
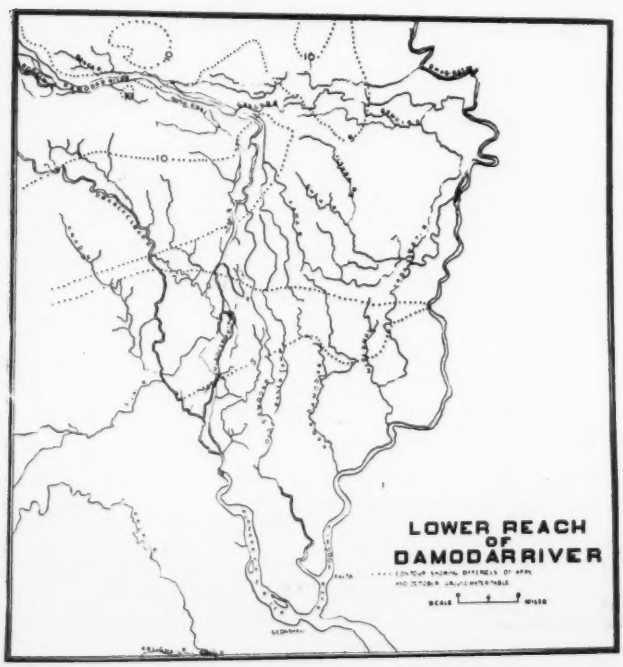


Figure 7

Site No /Sample No	Mouza P. S. & Dist. (in serial Order)	Soil Depth of collected Sample	Texture of Soil	Results of Analysis: Mechanical — Gravel	Coarse Sand 2-0.2 mm	Fine Sand 0.2-0.02 mm	Silt 0.02-0.002 mm	Clay <0.002 mm	Chemical — Total Salts	pH	Cabonate
21/1	Krishna-rampur	0′ 0″- 3′ 0″	Clay loam	—	1.2	55.5	13.8	26.5	0.165	8.0	Trace
21/2	Chanditala	19′ 7″-21′ 3″	Silt loam	—	1.3	10.6	45.4	39.0		7.6	Present
21/3	Hooghly	35′11″-38′ 3″	Heavy Clay	—	3.8	21.3	18.3	50.9		9.0	Present
21/4		43′ 4″-44′ 9″	Sandy Clay loam	—	17.4	52.6	4.1	22.1		8.4	Not found
22/1	Dakhin-bari	0′ 0″- 3′ 0″	Heavy Clay	—	1.6	7.3	22.9	62.1	0.144	7.4	Nil
22/2	Domjoor	12′ 4″-15′ 9″	Heavy Clay	0.2	8.9	5.7	25.7	53.6		6.9	Nil
22/3	Howrah	32′11″-36′ 8″	Sandy loam	0.2	1.8	66.8	15.4	12.0		8.4	Present
23/1	Baneswar-pur	0′- 3′	Clay loam	—	0.7	45.8	25.3	26.6	0.044	7.4	Trace
23/2	Amta	13′-17′	Light Clay	—	1.8	11.0	46.0	38.1		6.8	Present
23/3	Howrah	29′-30′		—	23.6	11.5	22.8	21.5		8.3	Present
24/1	Aima Chak-Bishnupur	0′ 0″- 3′ 0″	Sand	—	39.0	44.1	3.8	11.1	0.069	7.5	Nil
24/2	Jagatballav pur	12′ 7″-17′ 2″	Clay loam	—	1.3	33.2	28.5	33.3		8.4	Trace
24/3	Howrah	33′11″-37′ 1″	Medium Clay	—	8.3	14.2	24.6	46.7		8.4	Present
25/1	Kotalpur	0′ 0″- 3′ 0″	Clay loam	—	3.6	36.8	23.2	32.0	0.106	6.8	Trace
25/2	Jangipara	16′ 8″-18′ 5″	Clay loam	—	1.1	22.1	39.8	34.3		7.9	Present
25/3	Hooghly	27′ 1″-29′ 5″	Heavy Clay	—	1.8	12.5	25.2	56.8		8.1	Present
26/1		0′ 0″- 3′ 0″	Sandy loam	—	3.6	65.6	12.4	15.8	0.084	7.4	Not found
26/2	Rajhati (P.O. At-pur)	11′ 4″-14′ 6″	Medium Clay	—	5.1	27.3	21.4	39.5		7.8	Trace
26/3		17′ 0″-21′ 6″	Sand	—	44.0	39.2	4.9	10.7		8.0	Not found
26/4	Jangipara	26′ 7″-27′ 4″	Light Clay	—	5.6	22.9	25.7	38.2		8.4	Present
26/5	Hooghly	47′ 2″-49′ 6″		—	41.5	27.0	4.1	9.7		8.4	Present
26/6		59′ 3″-60′ 2″	Sand	—	72.2	16.8	2.5	3.7		8.4	Not found
26/7		65′ 6″-66′ 4″	Medium Clay	—	13.2	18.5	17.9	41.8		8.2	Present
27/1	Bhanjipur	0′ 0″- 3′ 0″	Clay loam	—	3.3	39.2	25.9	28.5	0.074	7.9	Nil
27/2	Tarakeswor	14′ 8″-16′ 0″		—	6.3	18.1	21.8	43.3		8.4	Present
27/3	Hooghly	27′ 9″-30′ 9″	Light Clay	—	19.0	19.0	15.5	37.5		8.3	Present
27/4		37′ 2″-38′ 0″	Sand	—	80.4	10.6	1.0	2.9		7.9	Not found



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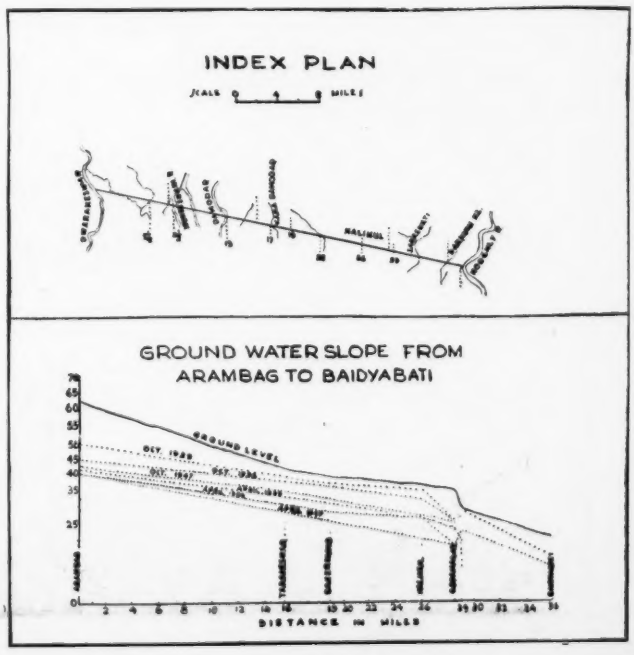
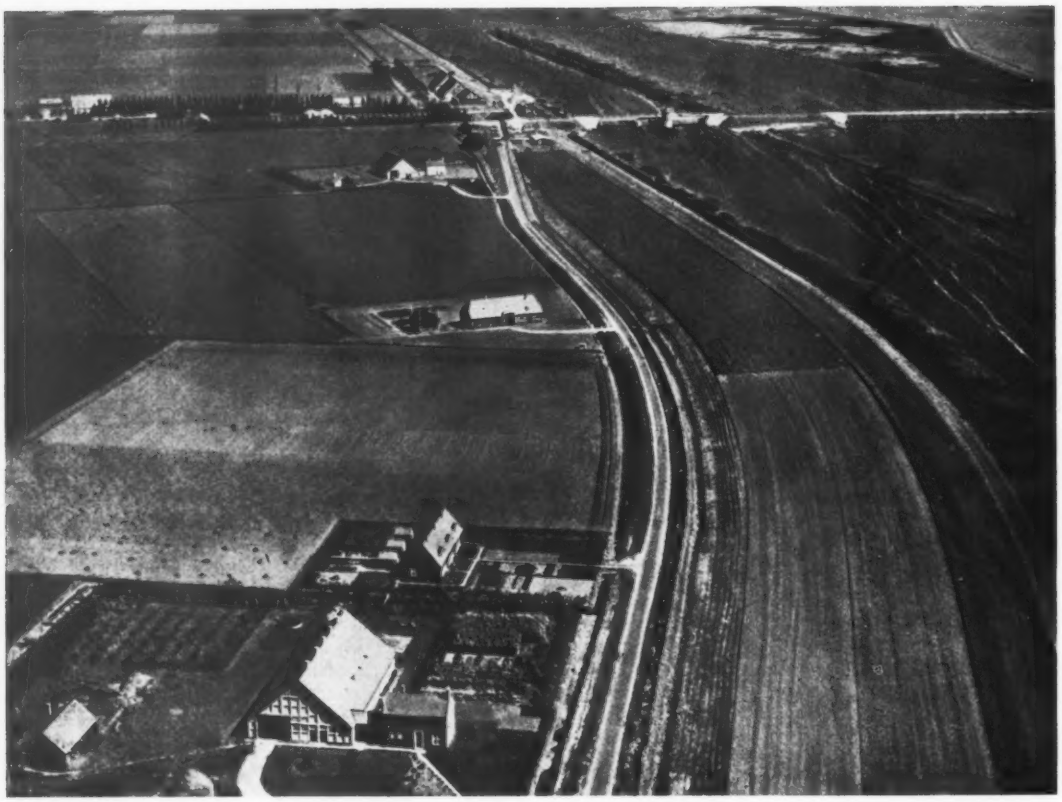


Fig. 8



New Land

The Netherlands are a small country with much water but fortunately they have an age-old tradition of turning water into arrable, inhabitable land. This photograph shows a part of the North-East Polder, an area of 185.45 square miles of new land reclaimed from the old Zuyderzee. The gigantic work of reclamation of the North-East Polder was commenced in 1936 with the building of a 34.15 miles long, arch shaped dyke from coast to coast through the Ijssellake, formerly the Zuyderzee. In 1940 when the dyke was ready, it stood in the middle of the water but after two years time the water which covered the present North-East Polder was drained off into the Ijssellake, new land and the old shore met. In the new fertile land 310 miles of road were constructed, canals were dug in order to keep this land below-sea-level dry, trees were planted and farms and villages built. The planning of all this did not only concern architects and engineers but also sociologists and economists. The reclamation and settlement of the North-East Polder is a project which has the attention of many countries which, like the Netherlands, are eager to provide room and appropriate means of existence for their population.

The Dam between two Seas

The Dutch call it the "Closing Dam" (Aflsuit Dijk) and it is a grand achievement of engineering planned and carried out within the scope of the Zuyderzee Reclamation Works which began in 1927. On 28th of May 1932 the Dam was ready and henceforth the Zuyderzee and the North Sea were separated. The Dam ended the connection between the North Sea and the water of what was from now on called "Ijssellake".

In the year 1300 the Zuyderzee was formed by a flood and through twentieth century reclamation works the Netherlands attempted to regain the 849 square miles of ground that the sea had taken away

(*Continued on page* 15)

Our Delhi Letter

(*From our Special Correspondent*)

The Industries Fair which has been the focus of attention and admiration by a vast multitude of people provided the Capital with an almost historic interest. The array of exhibits which were received from various lands attracted large crowds of visitors —many of them with notebooks in their hands. India is fortunate in having this fair at this crucial period when the second Five Year Plan avows the express intention of enhancing the country's industrial potential.

The duration of the fair was extended by about three weeks due to a persistent demand from the public that such a wonderful exhibition should continue to provide more education and information to the public. The management of the fair deserve the highest tribute and gratitude from all sections of the public for the unqualified success with which the big undertaking has been organised and conducted. Besides a lot of educative propaganda, active business deals have been consumated whereby important items of equipment have been sold by foreign countries to the Indian industrialists. Much more than these sales is the important time table that has been mutually agreed upon between India and the participating countries whereby further business understanding will be pursued.

Bhagra Power Plant Units

The Bhakra Turbines and Generators which were put out for bids in the global market by the Bhakra Dam Administration and the Electricity Branch, Punjab, have received world-wide response. Some 18 firms of repute put in competitive tenders giving particulars of the design and research techniques applicable to the specialisation achieved in various countries. Since these are the first units of such size (each turbine 125,000 H.P. each generator, 90,000 kW.) great responsibility rests on the shoulders of the civil and electrical authorities incharge of the Bhakra Dam in selecting the right type of equipment at proper cost. The Central Water and Power Commission and the Director General of Disposals were associated in the examination of the tenders. The final decision in the selection of equipment rests with the Bhakra Control Board who have the 'zonal' authority in respect of three participating states, viz., Punjab, Pepsu, Rajasthan, Government of India, Finance Department and Punjab Government Finance Department are also associated in the decision.

Biggest Power Plant in record time

This will be a test case in which the engineering organisations employed on the Bhakra Dam Project will be assuming responsibility for the construction of a very large size power plant in record time. The operations at the dam site are in full swing for the excavation of foundations of this powerplant and the construction of the penstocks. The target date for the completion for the Powerplant is 1959-1960. It is being increasingly felt that the market for the sale of electric power will expand along with and in fact sooner than the increase of generating capacity. It is a matter of common knowledge now that the entire power generation from the Ganguwal and Kotla Power House has already been allocated to waiting customers. The power from the Bhakra Powerplant is going to be utilised by the Nangal Fertiliser-cum-Heavy water plant almost from inception. The balance power from the Bhakra Nangal will be quite inadequate for the growing needs for the region, particularly Delhi.

Fertilizer-cum-Heavy Water Factory

The Fertilizer Plant to be constructed at Nangal by the Government of India will produce heavy water as an important by-product. The total power needs of this factory are estimated at 1,60,000 kW at 100% load factor. The plans for the design and construction of this project are yet in hand and Shri B. C. Mukharji has already started negotiations with foreign firms of consultants for the design and construction equipment necessary for this project. For the heavy water aspect the organisation incharge of the Atomic Energy Commission is being co-opted for this purpose. It is considered that it will be a very intricate and tough programme for the Fertilizer-cum-Heavy Water project management to have the factory completed and fit for operation by the time bulk power is available from Bhakra Dam.

Research and Design Coordination

In the context of further work on river valley projects embracing irrigation and hydro-electric power and flood control, the utmost coordination is becoming necessary between research and design. Not only is design making increasing demands on research for finding solutions for new problems but every problem is being studied at more than one research station in order to arrive at reliable results. With the elimination of delays and shortening of distances due to air travel and air-mail it is now possible for Punjab to coordinate with Bangalore and for Bengal to coordinate with Poona. The older engineers and other administrative Heads need to recognise that in the present tempo of progress all round, the problems of engineering need a very wide forum for their optimum solutions.

Talk on Bhakra Dam at the Delhi Centre of the Institute of Engineers

This factor was brought out force fully in a recent talk at the Institution of Engineers (India) New Delhi Centre, when their annual general meeting was held. Shri C. L. Handa of the Bhakra Dam Designs Directorate narrated how the design and construction of the Bhakra Dam were being based on the most upto-date techniques as evolved in India and other countries. The problems of Bhakra Dam, he said, were quite unique in many respects and for their opti mum solution advantage was being taken of the widest possible discussions within the country and the review of some of the findings by eminent consultants engaged from abroad. The final responsibility for all important decisions was taken by Indian

Management in consultation with the Central Water and Power Commission.

Delhi Rotarians discuss River Valley Projects

The subject of development in the agricultural and industrial fields through River Valley Projects with particular reference to the Bhakra Nangal Project found great favour with the Delhi Rotarians, who invited Shri C. L. Handa to address their group. The speaker presented in non-technical language the problems connected with the planning, organisation, and execution of the great project. A transformation in the lives of the inhabitants of the region at no distant date was picturesquely described and great interest was aroused in the select gathering who asked questions at the end of the talk. The role of Indian engineers in reference to foreign specialists engaged for the Bhakra Dam was explained. The necessity of betterment fee to be levied on the land deriving irrigation benefit was brought out. The dependence of the project on timely deliveries of steel was explained and the cooperation offered by other countries, notably U.S.A. was detailed in the context of uptodate procurement of know-how and equipment. The chairman appreciated the presentation of the technical subject in popular terms. Mere statistics about the potentiality and dimensions of such a huge undertaking are rather baffling unless the technical people take it upon themselves to interpret their significance in the immediate spheres of current programmes for the common man.

Implementation of Refresher Course Programme by Roorkee University

The first refresher course for serving engineers which was inaugurated at Roorkee in the beginning of November was greatly expanded by a tour of Delhi and Bhakra in which the serving engineers participated. The experts of the Central Water and Power Commission and the Bhakra Dam Designs Directorate along with some eminent engineers of the T.C.M. and the United Nations Technical Assistance Administration addressed the serving engineers on subjects connected with their field of specialisation. Shri A. N. Khosla, Vice-Chancellor of the Roorkee University was present at some of these lectures and he expressed his appreciation of the consciousness and awakening amongst the members of the profession, who had made the first experiment an unqualified success. The way had thus been paved for the success of the Asia Africa Water Resources Training Centre which was due to commence functioning at Roorkee from April 1956.

Second Five Year Plan : Simplification of Procedures needed

The outlay of nearly 1000 crores on River Valley Projects is visualised in the draft Second Five Year Plan, which is just emerging out of confidential stages. This huge outlay comes only next to the provision of about Rs. 1,200 crores for Railways. Both these sectors are dependent, by and large, on engineering personnel being able to formulate their vast plans and arrange their speedy execution. The programme is much bigger than what has been achieved in the First Plan, which had some clear advantages over the current plan. The projects and works undertaken in 1951-56 represented some 25 years of planning done under British Masters. Even though these plans were far from complete a lot of data had been collected and implementation was therefore expedited. The present plan has to start from scratch in many new fields and unless new methods and techniques are employed to solve the hurdles, slower achievement is a foregone conclusion. There is thus a bigger and stiffer test awaiting the administrators and engineers and action is called for right now. The direction in which action needs to be taken must be defined in a constructive spirit unless frustration and failure are to be faced when it is too late.

Wise Selection of Personnel and Elimination of Financial Red Tape

The cultivation of trust in the judgement of engineers whose record of achievement is already established seems to be the only approach if the collossal programmes are to be implemented. The administration should place a square challenge on the shoulders of engineers to furnish a guarantee for the accomplishment within the targets of time and money. Having done this in principle, the hurdles and impediments of petty financial procedures should be simplified without in any way releasing the vigilance which is needed to sense any wasteful or fraudulent expenditures. This can best be secured again us by delegation of authority for recruitment, reward and punishment in the trusted hands of engineers themselves, so that they have no opportunity to blame any of their failures on others. This gesture should lead in practice to the clear formulation of realistic programmes which should be discussed threadbare amongst selected personnel, who should have the responsibility to hammer out final details. Multiplicity of checks can thus be abolished without in any way reducing the effectiveness of control. Expenditures necessary for the investigation of details would be readily sanctioned and the rust and friction that in these days clog the various sections of the machine would be cleared away, leading to a smooth and harmonious progress. This course would definitely need some engineers and administrators to function at the top and it should not be difficult to find twenty such individuals.

Editorial

Afro-Asian Water Resource Development

It is appropriate that a Training Centre has been opened at the University of Roorkee for the trainees from African and Asiatic countries engaged in developing the resources of their largely untapped rivers. It is only recently that the countries in Asia and Africa are, as it were, rising from their age-long slumber (except of course Japan, Australia and New Zealand). And as they do so and take up the task of their economic rebirth and regeneration, it is but natural that they will concentrate their major attention to the development of their large rivers, both for irrigation and power purposes. Even the record of the last decade in India, Pakistan, Ceylon, Afghanistan and Thailand shows that this has been the case. Yet much ground has still to be covered within these countries and much more in the other countries in Asia and Africa.

These largely undeveloped countries have one great advantage on their side. They will be benefitted greatly by over a century's rich experience in water resource development in Europe and America. There much has been achieved no doubt but most of it during a period when the scientific understanding of the nature of rivers was far more inadequate than today, and as a consequence, these pioneering efforts involved lack of proper planning, wastefulness and serious inadequacies which are coming to light today. It is of extreme importance that the nascent countries of Asia and Africa take a full critical view of the situation as regards the science of river resource development both from the point of view of technique and engineering as well as of broad perspective and dynamics of development. Only then the new projects that are to be launched will give maximum economic fruits with the minimum of effort and in harmony with the principle of conservation of natural resources. Two important considerations arise in one's mind when making the above suggestion. One is that river resource development is more or less of an irreversible nature, that is, once the river is canalised in a certain pattern of engineering system, it can not be changed in its broad contours again. Therefore the most enlightened and scientific approach needs to be made with respect to each river system. To day we might, in our enthusiasm, think that we have plenty of water. But after a century of rapid unplanned development, we may find ourselves in the same position as some areas in USA or Europe which are desperately in search of more water today, unless we are careful from now on.

The other consideration is that most of the Asiatic and African countries are economically backward in terms of capital resources. Therefore much of the finance required for development of their rivers would have to come from outside and these have to be paid back from out of the benefits that these projects will accrue in subsequent decades. These projects have, therefore, to be extremely well planned both in the short range and the long range sense.

There is still another aspect that might be worth considering regarding the development of rivers. It may be debatable as to whether the political boundaries or the river boundaries are arbitrary. But it is a fact that the two are not always in harmony, particularly in the case of large rivers traversing through small states. Unless we are enveloped by an autarkic nationalist attitude as between different peoples living in Asia and Africa in the modern technology-dominated shrunken world, serious thought needs to be given even from now on as to how these large river systems that cut across national boundaries are to be scientifically developed for fullest human use, in mutual cooperation. This is a problem which has raised its head already, as for instance in the Indus Basin, and needs to be conceptually tackled from now. Much of the avoidable but almost-certainly-to-be-raised questions of this character may have the benefit of advanced study if the matter is seriously taken in hand.

Resource development of rivers is no longer a purely engineering subject today. It covers also the socio-economic aspects, and we welcome the fact that this broad classification of the subject has been kept in mind while planning the Training Centre at Roorkee.

It goes without saying that we welcome the opening of this much needed International Training Centre with all our heart. And we hope that around this Centre and the University, shall grow up serious studies of the manifold broad problems of perspective relating to the development of rivers in Asia and Africa. Because river resource development is certain to play a very significant and prominent role in the general economic development of these vast areas in the coming decades.

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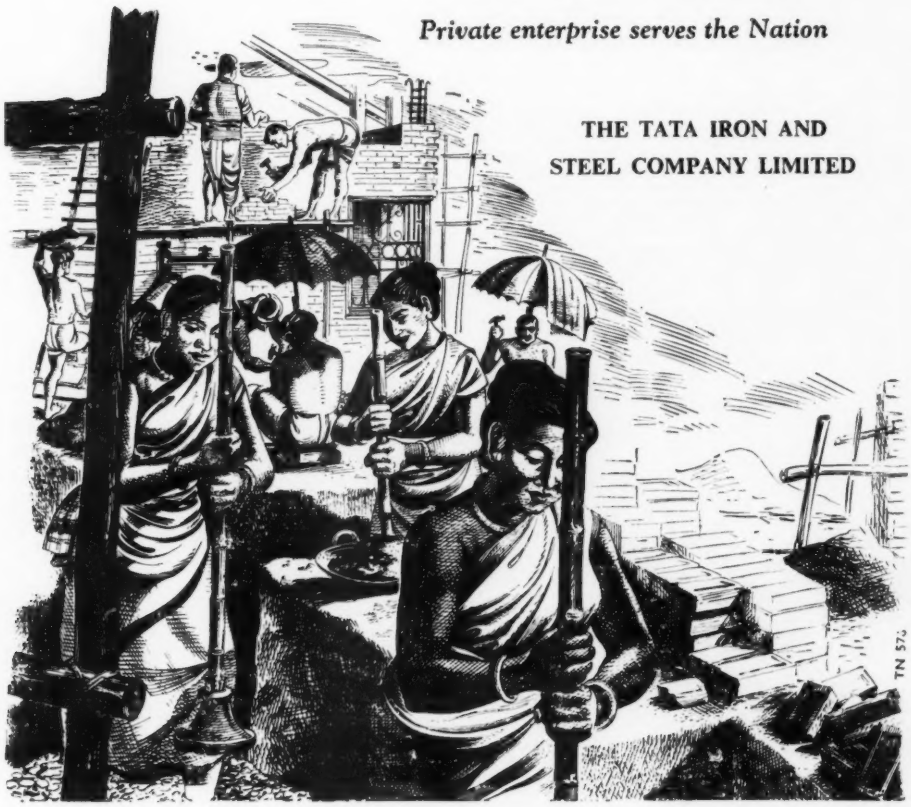

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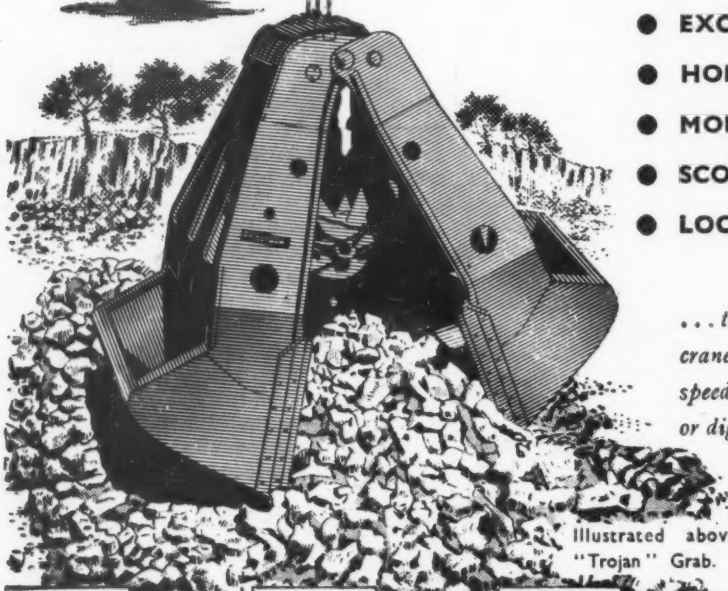

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